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INSTRUMENTS

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Devoted to Measurement and Control Problems

Vol. 4. No. 7 Pittsburgh, Pa. July, 1931

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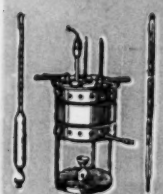

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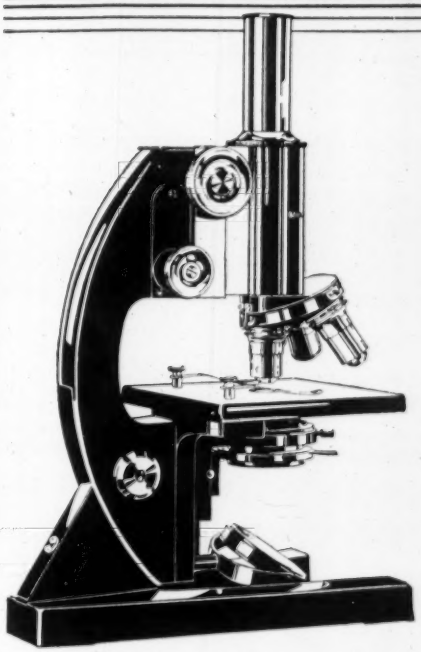

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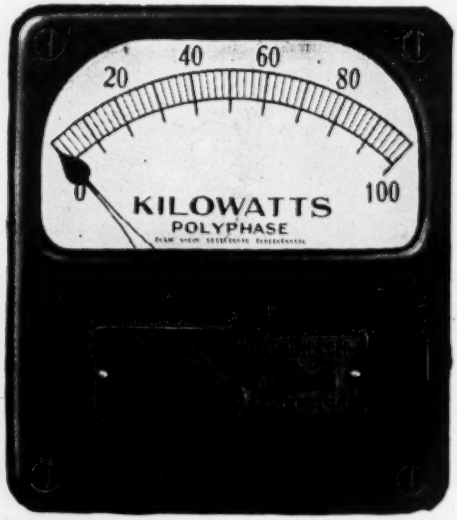
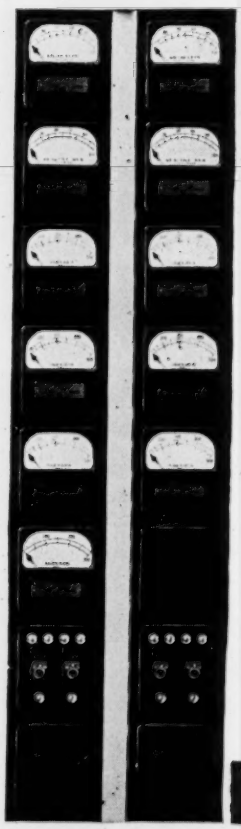


NEW



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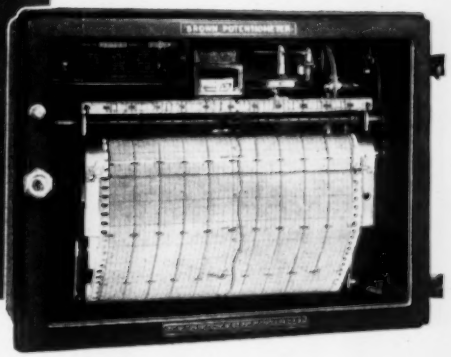

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Brown Potentiometer Catalog No. 1101 Sent on Request

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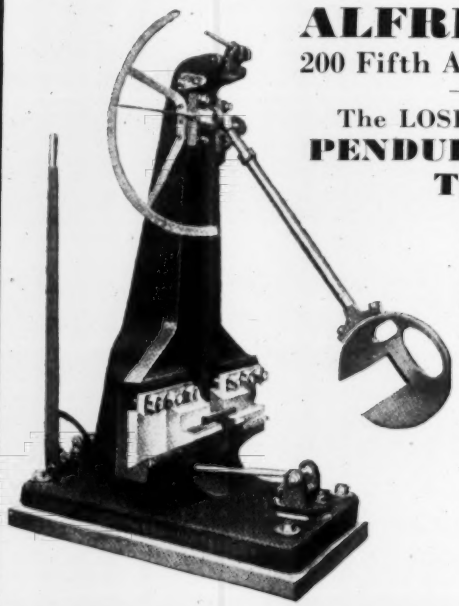

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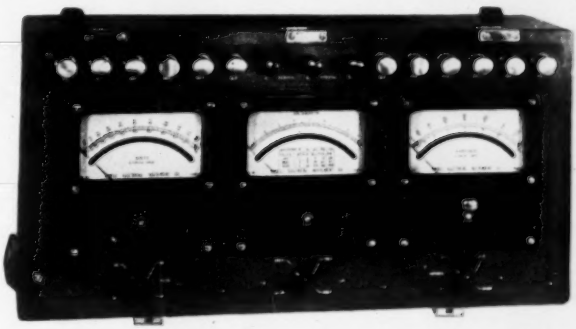
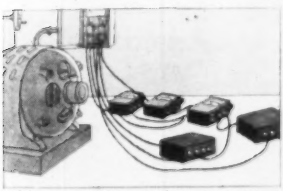
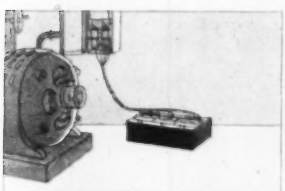
Jewell Announces the Pattern 177 Industrial A. C. Analyzer



An instrument of far reaching importance to industry



When separate meters are used to test three-phase power circuits, a complicated system of inter-connecting wires is necessary.



The Jewell Pattern 177 Industrial Analyzer makes all measurements made by many separate instruments. The only connections necessary are those direct to the control box.

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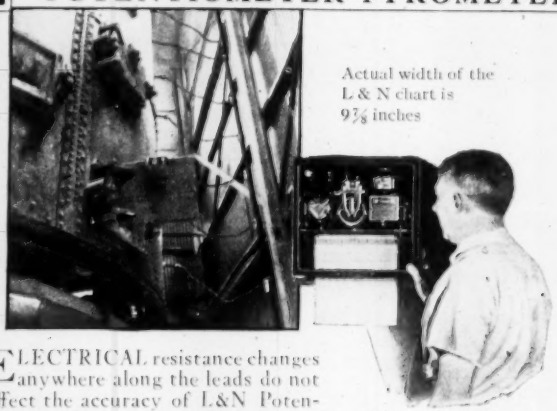

Actual width of the L & N chart is 9⅜ inches

ELECTRICAL resistance changes anywhere along the leads do not affect the accuracy of L&N Potentiometer Pyrometers. Wires may corrode at uninsulated points or contacts may vary at terminals and switches—yet if there is contact, readings stay within a deadline of 3° in 1000°.

And this is but one of the ways in which the L & N Potentiometer* Pyrometer is trouble-proof. This null potentiometer method of measuring temperatures—balancing the unknown thermocouple millivoltage against a known millivoltage from the instrument—is at once the most accurate and reliable in industry.

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L & N Catalog 84-I lists L & N Potentiometer Pyrometers for automatic temperature control. Catalog 87-I lists them for recording and for indicating. Special bulletins outline their application to various industries.

**Information as to the advantages of L & N Potentiometers will be sent on request.*

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For Indicating, for Recording and for Controlling Automatically

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Richard Rimbach, Managing Editor **M. F. Béhar**, Engineering Editor

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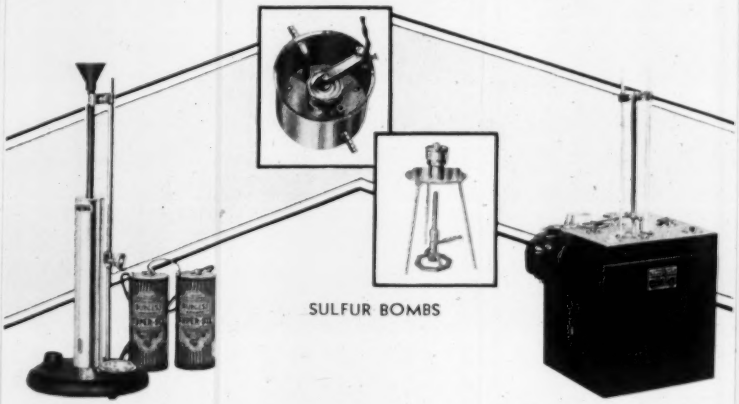

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The Sulfur Bombs, both electric and flame ignition types, are proving very popular for the determination of sulfur in fuels, foodstuffs, rubber compounds, organic carbons in soils and halogens in organic compounds. Write for Bulletin No. E10.

Burgess-Parr Calorimeters are well known in scientific circles for their accuracy, in speedy and simple B.T.U. determination. Write for Bulletin No. E 14.

Bulletins describing any of the above three instruments will be promptly sent you. Specify Bulletin Number.

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EDITORIAL COMMENT

Impressions of a Great Exposition

BACK from Chicago after attending the first international instrument show held in this country, we find it impossible to convey in mere words some of the impressions which this assembly of scientific and commercial equipment made on an interested beholder.

In this issue we give a brief and plain report of the exhibits as we saw them, one by one. But as we go to press we lack the time to synthetize the entire spectacle and distill the essence thereof. Nevertheless, one conclusion thrusts itself on our mind. It is the futility of attempting to define the territory of testing instruments. With praiseworthy intentions, the A. S. T. M. restricted the exhibits to "apparatus, equipment and machines used in the testing of materials." This was meant to keep out obviously unrelated products; and it succeeded admirably in holding the great symphony to the keynote. But any visitor who came with the idea that because he was interested and experienced in testing he "knew in advance what it was all about" had that idea knocked out of his head promptly—and most pleasantly! The managing editor of this publication cheerfully admits that he was wonderstruck; and he saw older and more experienced specialists, struck off their guard by unexpected triumphs of designing skill, staring and staring like little boys.

One often hears the remark that nowadays there is no such specialist as an electrician, a chemist, a mechanician, a biologist, an astrophysicist or a seismologist. The same applies to the field of testing instruments, in which the only rigid boundary is that of the A. S. T. M.'s officially published *tests*. But even this line cannot define testing machines and instruments. This field has expanded and is expanding almost as fast as the Einstein school of cosmologists aver that the universe is expanding!

INSTRUMENTS EMPLOYMENT SERVICE

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INSTRUMENT MAKER: 7 years experimental laboratory of electrical company. J-1.

INSTRUMENT MAKER: 3½ years experimental laboratory of lamp company; 2 years experimental laboratory of electrical company. J-2.

PYROMETER MAN: Graduate Pennsylvania State College. Had charge of pyrometer calibration laboratory in plant with 1100 pyrometers. J-3.

METALLURGIST: 1½ years University of Pennsylvania; 7 years night school Carnegie Institute of Technology. 2 years steel plant analyst; 7½ years plant metallurgist in foundry. Can read German, Polish, Bohemian and Russian. J-4.

METALLURGIST: Graduate University of Pittsburgh; 5 years steel plant metallurgist; 6 years sales metallurgist; 3 years metallurgist automotive plant. J-5.

ELECTRICAL ENGINEER: Graduate Charlottenburg Technische Hochschule; 8 years research engineer with chemical company; 4 years steel plant electrical engineer; can read German, French, Spanish and Italian. J-6.

METALLURGICAL ENGINEER: Graduate University of Cincinnati, M. S. Carnegie Institute of Technology; research metallurgist steel plant 4 years; development engineer instrument company 1½ years. J-7.

INSTRUMENTS BOOK SHELF

The books reviewed in this section can be supplied by the Instruments Publishing Company.

Applications of Interferometry. *By W. Ewart Williams.* E. P. Dutton & Co. New York, 1931. Cloth, 104 pages. Price 85 cents.

Just as the analytical balance of the last decade is being replaced by the microbalance, so also is the millimeter scale being replaced by the interferometer which splits a wave length into a thousand parts. With these new developments has come a need for more definite information on the "playtoys" of yesterday's scientists which are becoming today's industrial control tools.

Although primarily intended for advanced students, this monograph contains many essential discriminatory data on interference methods and apparatus. The various interferometer systems are discussed from their optical as well as mechanical aspects with due emphasis being placed on the industrial applications. The Michelson, Rayleigh, Benoit Fabry, Kennedy and other interferometers are all described in sufficient detail to enable one to review the subject and determine for himself the possible applications to his own work whether it be the standardization of gage blocks, microscope objectives, prisms, plane parallel plates or other measuring devices of extreme precision.

A rather complete bibliography and numerous figures considerably extend the scope of the book.—Arthur Schroder.

Staudruckmessung Bei Pulsierenden Stoffstromen. *By Gustav Sauer.* Verlag Wilhelm Knapp, Halle, 1931. Paper, 5½x8¼ inches, 72 pages. Price 4. R.M.

The first three chapters, pages 1 to 22, cover the general theory of averaging pulsating flows. Equations are given to arrive at a correction factor which is assumed to be the ratio of the square root of the average to the average of the square roots of the momentary differential pressures. The equations are given for various assumed conditions of time intervals with and without a part of continuous flow in the line.

The fourth chapter discusses instruments for indicating and correcting errors in pulsating flow.

Chapters 5 to 9 are devoted to construction details, installation, experimental testing, and practical application of a new rate correction device. This device was shown to register directly the average of the momentary square roots of the differential pressures.

Chapter 10 describes a number of other instruments available for measuring pulsating flow.—J. M. Spitzglass.

Die Optischen Instrumente. *Moritz von Rohr*, Fourth Edition. Julius Springer, Berlin, 1930. Paper, 5½x8¼ inches, 130 pages. Price, 5.70 R.M.

This book is descriptive rather than mathematical yet the use of some mathematics is unavoidable. The author is a member of the Scientific Staff at the firm of Carl Zeiss and is a recognized authority in the field. The book is written in his usual clear style and may be especially recommended to students of German who wish to acquaint themselves with the vocabulary of this subject.

The book is divided into three parts. The first, only sixteen pages in length, is a summary of the elementary or first order theory of optical imagery. The second, slightly longer, describes the structure and functioning of the eye, binocular vision, and the different types of spectacles. The third part, containing 85 pages, forms the main body of the book and describes the common types of optical instruments according to the following rather novel classification: A. Instruments which aid vision, including magnifiers, microscopes, and telescopes. These enable one to see greater detail than can be seen with the unaided eye. B. Instruments which reproduce the image, including those such as the periscope which have no tangible intermediate image, those such as the camera which produce a tangible image, and those such as the projector which present this image to the eye. The purpose of these is to enable one to see an image of an object which may not be directly visible to him.—H. F. Bennett.

Ueber die Entwicklung der Theorie der Optischen Instrumente seit Abbe. *H. Boegehold.* Sonderabdruck aus Band VIII, "Ergebnisse der exakten Naturwissenschaften." Julius Springer, Berlin, 1929. Cloth, 6x9¼ inches, 146 pages. Price, 39.60 R.M.

This book was written by another member of the staff at the Zeiss works, and, in contrast to von Rohr's book, it is extremely mathematical and completely devoid of diagrams and illustrations. There are numerous footnote refetences which taken together form a fairly complete bibliography of recent investigations in the theory of geometrical optics. The book is intended for those who are specializing either in theoretical optics or in lens designing.

First an historical sketch is given of the development of the theory of optical instruments as set forth by Abbe. Next the question of the definition and classification of optical instruments is discussed. A mathematical treatment follows which comprises the following subjects: (1) the various forms of the Eikonal as developed by Hamilton and Bruns and more recently by T. Smith, (2) the general conditions of imagery and optical projection, (3) symmetrical optical systems, and (4) the conditions for sharp and distortion-free imagery.—H. F. Bennett.

View down Aisle A looking toward entrance

First Exhibit of Testing Apparatus and Machines

Richard Rimbach

THE first national exhibit of testing apparatus and machines took place recently, when the Exhibit of Testing Apparatus and Machines was held in conjunction with the Thirty-fourth Annual Meeting of the American Society for Testing Materials at the Stevens Hotel, Chicago, June 22-26, 1931. A record attendance of almost 1,500 members and visitors was the result.

Twenty-seven instrument manufacturers, five A.S.T.M. committees and five company research laboratories, as well as government bureaus and a university laboratory, maintained displays in the exhibition hall, showing practically every type of testing equipment and apparatus employed in all industries.

A wide variety of instruments and apparatus was exhibited in which improvements and refinements have recently been made. A detailed account of many of the interesting points of the show follows:

Physical Testing Machines

The greatest interest was shown in physical testing machines; ten manufacturers showing this class of equipment:

Baldwin-Southwark Corp. demonstrated their latest model 60,000-lb universal testing machine as well as the Wazau Brinell tester, the Foeppl-Pertz damping tester, the Foeppl-Heydekamp fatigue tester, Huggenberger tensometers, Whittemore strain gages, Peters electric telemeters, Oxweld portable tester, a portable concrete beam tester, the Geiger Pi-meter, the Geiger Torsiograph and Lehmann & Michels engine indicators.

Fred S. Carver showed several hand-operated, hydraulic, laboratory presses with accessory equipment. These accessories permit the application of the press to many different tests.

J. B. Hayes, Inc. had the following testing machines on display: A Moore extensometer, rotating beam testing machine, a repeated torsion, repeated tension machine, and a reversed bending machine. In addition this company showed diffraction X-ray apparatus, including the spectrograph with universal adjustment of table and pinholes, camera, flat cassettes, semi-circular cassettes, wedge cassettes and the oscillating spectrograph.

Morehouse Machine Company exhibited proving rings for checking testing machines as well as apparatus for testing the springiness of magnet wire.

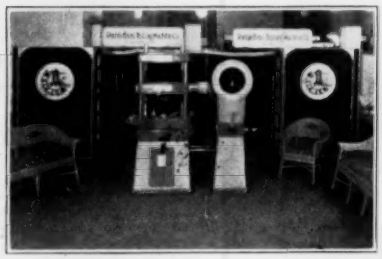
Riehle Bros. Testing Machine Co. demonstrated their latest development—a precision hydraulic universal testing machine. This machine embodies many new and unusual features.

The Shore Instrument and Manufacturing Co. showed the Monotron static constant diameter hardness indicator and the Scleroscope vertical scale and dial recording hardness testers.

Steel City Testing Laboratory had a Krause universal testing machine. This machine has a number of novel features. Other equipment displayed comprised a transverse testing machine, a power-operated Brinell machine, a new style sheet metal tester and a compression tester for concrete cubes.

In the exhibit of *Alfred Suter* the Losenhausenwerk hydraulic universal testing machine and the lathe tool dynamometer created unusual interest. The other items in the exhibit included a Charpy impact tester, a high temperature creep testing outfit, a portable Brinell tester as well as a large Brinell tester.

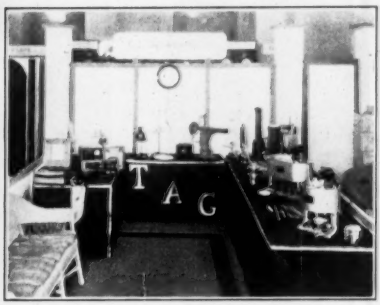
Testing Machines, Inc., showed a wide variety of testing machines for practically all materials: Tensile testers for metals, paper, textiles, rubber; Bending testers for wires



Riehle Bros.

Brown

Alfred Suter



Tagliabue

tin plate, insulating materials, cardboard, linoleum; Standard and portable Brinell testers, impact hardness tester, hardness tester for soft rubber, scratch hardness tester for varnish films, wire torsion tester. Paper testers including: folding endurance, Schopper-Dalen bursting strength, standard micrometers and thickness gages, basis weight and automatic scales, freeness tester for pulp and beater stocks, standard tensile, rapid strength and stretch, and expansion testers, cardboard, air permeability, ash and bulking, and blotting paper tester. Rubber testing apparatus including: detrition tester, rubber abrasion and resiliency testers. Impact testers, bursting strength tester for fabrics, etc.

The Thompson Grinder Co. had an R. R. Moore fatigue testing machine in operation.

Optical Instruments

Optical instruments were exhibited by three firms (in addition to J. B. Hayes mentioned above):

Bausch & Lomb Optical Co. had a complete line of metallographic equipment, research and wide-field binocular microscopes, a quartz spectrograph, a color comparator and a hydrogen ion colorimeter.

The display of the *Gaertner Scientific Corporation*, comprised a complete line of spectrographic instruments, the largest being a Littrow type spectrograph for quantitative analysis of metals and alloys. Another type of instrument, which adapts itself to many testing problems, was the tape chronograph, a device capable of measuring short intervals of time to an unusually high degree of accuracy. The timing is accomplished by comparison with an accurate vibrating tuning fork, which has a frequency of 100 vibrations per second.

The records are made on an especially sensitive moving tape driven by a high speed motor, and upon which tracings of the fork are made. The tracings appear in a sine wave-form equivalent to 1/100 of a second and in terms of linear measurements about 1 cm. long, thereby offering an easy subdivision for estimating times to 1/1000 of a second. The events, adjacent to the time curve, are recorded by especially designed pens operated by electro-magnets. The complete line of measuring instruments was exhibited, ranging from small micrometer slides for quick and rapid measurements of linear dimensions to a very precise type of comparators. Cathetometers and other vertical measuring devices were presented, permitting adaptation to all fields of testing laboratory equipments. Among these was an apparatus for determining creep of metals and alloys, which consists of two micrometer microscopes movable in the vertical plane, the optical axes of which are placed exactly 2" apart.

E. Leitz, Inc., showed the following: Microscopes for examination of metals, for observations in polarized light and complete line of other microscopes and accessories. New Differential Dilatometer. Photomicrographic cameras and accessories. Equipment for ultra microscopic investigations.

Thermometers and Pyrometers, Oil Testing

The Brown Instrument Company's exhibit aroused special interest as a result of showing their new recording and controlling potentiometer pyrometers. The rest of their exhibit covered: indicating pyrometers of all types, recording and integrating flow meters with automatic recording planimeters, continuous record liquid level recorder.

View down Aisle B looking toward entrance

The Precision Thermometer and Instrument Co. had a very interesting display of thermometers. A feature of their exhibit was a case which contained the various thermometers referred to in the A.S.T.M. specifications.

Rascher and Betzold displayed thermometers and hydrometers, as well as a recent development of theirs: the S. D. C. Senior model hydrogen ion kit.

Thermometers were also shown by the *C. J. Taghabue Manufacturing Co.* Other items in this booth were: Color apparatus including: Union colorimeter, Saybolt chromometer, daylight lamp. Thermostatic viscosimeter, with Universal and Furol top. Heppenstall moisture meter, for wood, and grain. Burning test apparatus including: Saybolt testing lamp, Rather burning test gage, recorder thermometer. Oil and moisture in wax apparatus. Cloud and pour test apparatus. Carbon residue apparatus, distillation apparatus. Flash point equipment including: Pensky Martens tester, Cleveland Open Cup tester, closed tester.

Sieves

The Newark Wire Cloth Co. showed testing sieves and wire cloth. A 400 mesh wire cloth in this exhibit is claimed to be the finest wire cloth ever made.

The W. S. Tyler Co. exhibited: testing sieve shaker complete with sieves and Stop-Rite. Torsion balance equipped with brass weights. Sample splitters. Standard field sieves. Miscellaneous samples of wire cloth of various meshes and metals. Set of 12 in. diameter coarse mesh testing sieves.

Other "Commercial" Exhibits

Christian Becker, Inc. had various analytical chainomatic balances, and chemical and laboratory balances on display.

The Burgess-Parr Co. aroused considerable interest by demonstrations of the Razek-Mulder color analyzer and the Burgess acoustimeter. Other apparatus in this booth were: calorimeters, the melting-point apparatus and the turbidimeter.

The Central Scientific Co. showed: Asphalt and creosote oil testing equipment: ball and ring apparatus, distillation and dehydration apparatus. Thermostatic water bath. Oil testing equipment: carbon residue apparatus, crank case dilution apparatus, gasoline distillation apparatus, flash point tester, sulphur apparatus. Laboratory research and testing instruments and equipment.

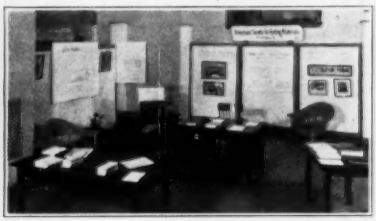
The Consistometer Corp. demonstrated the Stephens mechanical consistometer, an instrument for indicating and recording the true lubricating values of oils.

The Emil Greiner Co. showed: Petroleum testing apparatus. Constant temperature viscosimeter baths. Herschel friction apparatus. Various colorimeters. Penetrometer, improved form. Absolute viscosimeter (Vogel-Ossag).

The Humboldt Mfg. Co. display covered cement and asphalt testing apparatus: Ductility machine, adhesion machine, penetrometers, asphalt briquette and pitch molds. Penetrometer and delimeter. Asphalt viscosimeter. Softening point apparatus, flash point tester. Grease consistometer and needle. Shear machine for asphalt. Cement molds of all types. Mechanical cement fineness shaker. Cement consistency and set-time testers. Dureka Testing Outfit. Flow table, slump cone. U. S. Standard sieves, screens for field testing.

The Precision Scientific Co. and *E. H. Sargent & Co.* showed laboratory apparatus and equipment.

Burgess-Parr



A. S. T. M's own booth

The Educational Exhibits

Many of the educational exhibits displayed instruments and apparatus for testing. These were developed by companies to carry out work in their research laboratories and for which no instruments at present on the market were found suitable. This equipment cannot be bought.

The *Aluminum Company Research Laboratories* had some very interesting testing machine for their sections (12.6t kg. load, 1/10" ball); a rivet extensometer for measuring initial tensile strain in rivets reading deformation directly to 0.0002"; a three-directional strain measuring device for use under water in connection with model dam tests for use in measuring strains on upstream face of a model dam made of a special rubber compound. This latter instrument has jeweled bearings and is used under water, each division represents deformation of 0.0025".

The A.S.T.M. Committee on Magnetic Analysis demonstrated the Hughes induction balance; induction bridge with oscilloscope and galvanometer detectors; apparatus for chain testing and continuous testing of razor blade steel; the non-destructive test for locations of flaws by using magnetic dust aroused the most interest.

The A.S.T.M. Committee D-18 on Natural Building Stones showed: Core-cutting device used in compression tests. Shear punch used in shearing test. Rocker arm developed for bearings in flexure tests.

The Bureau of Standards of the City of Los Angeles demonstrated testing machines developed and used by them: compressive cement compaction machine (this machine uniformly compacts mortar for the compressive strength test of cement, variations inherent in hand tamping are largely eliminated); Vialog (this device, drawn by a motor car, makes a graphic record of unevenness in road surfaces, and counts all irregularities which exceed a specified limit); Auto-set (determines initial and final setting time of cement pastes, a large number of samples

can be tested without attention from an operator); bituminous mixture extractor (this apparatus extracts the bitumen from large samples of asphaltic concrete); Los Angeles rattler, (this device combines abrasion and impact in the testing of rock. The charge consists of iron cubes and a graded sample of rock; about 18 minutes are required for the test).

The Bell Telephone Laboratories, Inc. had a number of very interesting machines in operation: a filament wire extensometer (measures the load-deflection rate of very small wire such as is used for vacuum tube filaments and light valve ribbons); a compressibility machine (permits studying the compressibility of hard rubber, plastics and other products at different temperatures. The load applied may be changed for different materials); a pressure indicating micrometer (measures the thickness of resilient or compressive sheet insulating materials under conditions of constant presure. The pressure on the anvils may be changed by varying an externally applied load); a reversed bend testing machine (is used to measure the ductility,

Western Electric and Bell Laboratories

toughness, and resistance to deformation of sheet metals); a sheet metal fatigue machine (permits testing 40 specimens of sheet metal of varying thickness simultaneously); a photographic recording device (for measuring the deviation from parallelism and the flatness of telephone transmitter diaphragms).

The Western Electric Research Laboratories exhibited: the Reed gage for wire diameter (electric signal type Reed gage applied to accurate control of size in drawing fine copper wire, accuracy within 0.00001"); an optical Reed indicating gage (a comparator embodying the Reed gage for precision size blocks and end measurements); a fibre tubing torsion testing machine (for applying light torsion loading at a uniform rate to fibre tubing); a paper porosity tester (used to determine the porosity of paper 0.0004" thick); a resiliency paper tester (for measuring thickness and resiliency of laminated paper washers under various loads); a ballistic test set (used for measuring magnetic properties by Rowland ring method. Testing fixture eliminates the necessity of winding coils on the test sample).

The United States Bureau of Standards showed the following instrument developments made by them: Tuckerman optical strain gage; an eriometer (for measuring fibre diameter by diffraction of light); flexometer (for measuring permanent wrinkeability of fabric by measuring the energy required to fold, and the energy recoverable after folding the fabric); a furnace for testing compressive strength and deformation of structural materials at high temperatures; a portable spark accelerometer; a modified psychrometer; a comparator microscope for comparing bullets, etc.; an inspector's field kit for checking cement testing apparatus (includes: psychrometers, test balances and weights, test burrette, micrometers and calipers, stop and go gages for testing briquet molds, calibration lever for testing tensile machine); recommended cement testing apparatus (Vicat apparatus, Gilmore needles, graduates, briquet mold, standard 200 mesh sieve, fineness samples, standard Ottawa sand).

The Department of Engineering Research, University of Michigan had a very interesting exhibit, which contained the following: a creep test machine (for measuring the creep characteristics of lead at liquid air temperatures); dynamometer equipment (developed to measure the power generated by fractional horse power motors); sound analyzing and measuring apparatus (for use in measuring magnitude of the various frequencies composing the sound emanating from a machine); a paint spreading machine (for making paint, varnish or lacquer films under controlled conditions. Micrometer adjustments control the size of opening in the feeder and the height of the feeder from the plate which is usually of glass); a mercury contactor (used in connection with heating tests on household radiators); a machine for testing the green bond strength of cores; a core permeability test machine; a core crushing strength machine.

The Research Laboratories of the Westinghouse Electric & Manufacturing Co. exhibited: a miniature hydraulic testing machine for tension, compression and bending tests having a capacity of 60 lbs.; a 3 inch-lb. capacity torsion tester for fine wire; and a miniature fatigue tester.

Professor Samuel Wilson Parr

By

Jackson Burgess

ON May 16th, 1931 Professor Samuel W. Parr, one of the country's leading industrial scientists, and perhaps the most beloved man in chemistry, died suddenly at his home in Urbana, Illinois. The accomplishments by which chemists and instrument users know him have been fully described by others, and are only briefly stated here; but, his rare personality for which he was loved by hundreds of students, associates, and fellow scientists, is the subject which I want to emphasize in this brief and incomplete biography. My personal impressions of Dr. Parr are best classified by considering him as a student, a chemist, an instrument designer, a teacher, a boss, and as a friend.

Professor Parr

As a Student—

The records of the University of Illinois show that S. W. Parr entered that institution in 1880, and received the degree of Bachelor of Science in 1884. While a student there of chemistry he not only pursued this chosen field, but was also active in collegiate affairs. He was a member of the Varsity baseball team in those days before the university athletes were rewarded by the now much coveted orange "I," and many are his friends who remember the thrill and pleasure he received when in 1924 the "I" was given him, not only for his past prowess as a second baseman, but for his continued active support of university athletics. In addition, he was editor of the Daily Illini, the student newspaper; president of the University Y. M. C. A.; president of the Philomathean Literary Society; and, valedictorian of his class. Seven years later, when he returned as a teacher, he organized and became the leader of the Glee Club, an activity in which he always was interested.

His other recorded accomplishments as a student are the earning of his M. S. degree at Cornell University in 1885, and his graduate studies at the University of Berlin in 1900, and at the Polytechnikum, Zurich in 1901.

These recorded days as a student cannot do him justice for throughout life he remained a student of his chosen field of chemistry. These unrecorded studies are evidenced by his contributions to the scientific world, and for these accomplishments, and for his success as a teacher, he received honorary degrees of Doctor of Science from Lehigh University in 1925 and from Illinois College in 1929.

As a Chemist

As an investigator in chemistry, Professor Parr solved many perplexing and profound problems, all of which are fully described in his many papers published in the chemical journals. One of his earliest accomplishments, the successful use of sodium peroxide for calorimetry and for analytical purposes in determinations of sulphur, carbon, and halogens in diverse materials, formed the nucleus of what is now the Burgess-Parr Company.

His studies of coal culminated in his proposed classification of coal upon a corrected calorimetric basis, a classifying method which is now generally accepted, and in the successful coking of Illinois and other coals by the Parr Mid-temperature Carbonization Process, for the development of which the Urbana Coke Corporation was organized. There were other achievements in his study of coal, many of which are solely credited to him and many more of which were inspired by him and developed by his associates.

A third investigation which has become commercially significant is the establishment of the cause of caustic embrittlement in boiler plate, and its prevention.

In metallurgy he developed Illium, an alloy originally used for calorimeter bombs and in which application it has successfully replaced platinum and gold. Much of his work in recent years was in the constant improvement of this alloy to resist severe corrosion, and his success is established by the success of the alloy, which is widely used in the chemical process industries.

As an organizer for the promotion of chemical knowledge Professor Parr is remembered with esteem and gratitude by the American Chemical Society, in which he was always active and for which he served as President in 1928.

As an Instrument Designer

The successful commercialization of the Parr Peroxide Calorimeter, the Parr Sulphur Bomb, and the Parr Oxygen Bomb Calorimeter with the Illium Bomb, is evidence of his ability and prominence as a designer of laboratory instruments. In addition, he devised a hydrogen comparison gas calorimeter and in recent years he developed a continuous automatic recording gas calorimeter.

As a Teacher

His official career as a teacher included five years as an instructor at Illinois College and thirty-five years as Professor of Applied Chemistry at the University of Illinois. An inspiring teacher, he started many of his students on the road to success, and the great number of men who remember him as the outstanding factor in their curricular work has been impressed upon me by the hundreds of his former students I have met and talked with. Always there is a story of how he assisted his students in solving their problems, whether those problems were chemical, physical, or purely personal.

Professor Parr's remarkable ability to inspire his students and to help them with their problems kept him always surrounded with younger men who wanted to tackle his tasks and work for him. This fortunate circumstance now makes it possible for his researches to be continued by men who know his methods and who are capable of carrying on.

As a Boss—

In commercial work, Professor Parr was active as the presdient of Burgess-Parr Company, and as president of the Urbana Coke Corporation, and it was in these capacities that I knew him best. As my superior in both of these commercial activities, he combined all of his traits as a student, teacher, scientist, and friend, not only for the promotion of business matters, but for the development of his younger associates. The result of this willingness to teach his subordinates the methods of solving technical problems has now become a hidden asset to those corporations which he headed as president and technical director.

As a Friend—

Professor Parr was a friend of all who knew him, and his continued interest in his former students has endeared him to a large proportion of the nation's chemists. Further than that, his activities in the Y. M. C. A kept him always in touch with younger men, who learned to love him in direct proportion to the length of time they knew him.

However he may be remembered, whether as a scientist, teacher, or inspiring friend, the most suitable statement which can be made is his own favorite expression of esteem for others, "He was a great Parr."

C. C. Neale, of the Toledo Scale Company, Toledo, Ohio, has been elected President of The National Scale Men's Association. Mr. Neale is recognized as one of the foremost authorities on weights and measures, and is fully conversant with world weighing practices. He has been connected with the scale industry for over forty years, the last eleven of which have been with the Toledo Scale Company. Twenty-one years ago Mr. Neale was instrumental in founding the first Scale Men's Association in the United States and was its first president. His election to the presidency of The National Scale Men's Association is outstanding recognition of his two score years of scale experience.

H. R. Bowers, formerly with The Bailey Meter Company, is now manager of sales and advertising for The Meriam Company, Cleveland, Ohio, manufacturers of Flow Meters.

George F. Newell has been elected Vice-President and General Manager of the Pyrometer Service and Supply Corporation, located at 1988 East 66th Street, Cleveland, Ohio, which is a subsidiary of the Claud S. Gordon Company of Chicago, pyrometer and industrial X-ray engineers. Mr. Newell was formerly the St. Louis representative of the Charles Engelhard Company, and more recently the Chicago representative of the same firm.

Frank K. Billett, for the past eight years head of the Cost Accounting Department, has recently been appointed Secretary of the Toledo Scale Company, Toledo, Ohio. Mr. Billett has been connected with the Company for over ten years.

R. D. Bean, formerly Manager of the Engineering Development Department of The Brown Instrument Company, Philadelphia, has been made Chief Engineer of that company. Mr. Bean's extensive field investigations covering many applications of Brown industrial measuring instruments have won him wide acquaintance and his numerous friends will be glad to hear of his promotion.

At the annual meeting of the Burgess-Parr Company, the following officers were elected: *Chairman*, C. T. Burgess, *President*, Jackson Burgess, *Vice President*, B. S. Reynolds, *Secretary*, W. D. Staley, *Treasurer*, Jackson Burgess.

The Ellison Draft Gage Company of Chicago announce the appointment of Craun-Liebing Company, 30 Euclid Arcade, Cleveland, Ohio as exclusive representative in the Cleveland territory, including northeastern Ohio.

THE HANDBOOK OF INDUSTRIAL INSTRUMENTS

CHAPTER XV

Speed and Acceleration

M. F. Béhar*

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6.	Chronometric Tachometers		
7.	Centrifugal Weight Tachometers — Fly-ball		
8.	" " " Cross-pendulum		
9.	" " " Tilting ring		
10.	" " " Ball-and-cup		
11.	Centrifugal Fluid Tachometers — Liquid cup		
12.	" " " U-tube		
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20.	Frequency Meters		
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23.	Chronographs and Oscillographs		
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25.	Accelerometers		
26.	Automatic Speed Control		

1. General Remarks, Classifications, etc.

(a) Forms of Speed

Speed has two different sets of meanings in industry. One is "speeding up." The other comprises and fuses two physical magnitudes: the scalar "speed" and the vector "velocity."

On the one hand—in its socio-industrial aspects—it vaguely signifies a supposedly typically American ideal; it is associated with the concept of efficiency, and it is nearly always present at the back of our minds, where it evokes a shadowy hodge-podge of connotations ranging from the desirable through the profitable, the innocuous, and the merely expedient or tolerable, all the way to the burdensome, the obnoxious and the utterly detestable—all shades of meaning of "speeding-up."

On the other hand it designates a well-understood, always measurable and nearly always controllable operating and processing condition—an extremely important condition. This is the only aspect of speed dealt with here—the engineering aspect, and more specifically what may be called "mechanical" speed—that of plant equipment, of vehicles, etc., since the measurement and control of speed of fluids is excluded, being treated in subsequent chapters on Flow. (The measurement of the speed of aircraft and of ships in their respective mediums is also considered there.)

*Engineering Editor

The importance of operating or processing speed as a factor affecting costs, quality and uniformity requires no emphasis. Equally important are coördination and synchronization—involving the relative speed of all processes and operations in a plant or department, and requiring careful studies of instrumental measurements and records with a view to the extension of automaticity.

Mechanical speed may bear a direct relation to fluid flow speed, as in the case of pumps. In electrical machinery its association with voltage, current, frequency, etc., is obvious.

Speed often bears also a direct relation to duration of exposure to processing conditions. Examples, the speed at which materials are conveyed or passed through continuous ovens, calciners, dryers, acid baths, dye vats, etc. Duration, sequencing and condition-time curve control are all related to speed, but they constitute a special branch of instrumentation, dealt with in Chapter XIV.

This chapter deals, then, with three (or four) forms of speed that are instrumentally measurable:

(1) The number of regularly recurrent events per period of time, i. e., frequency, generally expressed in cycles per second or strokes per minute;

(2) Angular (or rotational or rotatory or rotative) speed, generally expressed in revolutions per minute (r.p.m.);

(3) Linear speed, expressed in feet per minute (F.p.m.); meters per minute (m.p.m.), miles per hour (M.p.h.) or inches per second (in. per sec.) depending on the industry or branch of engineering concerned.

[(4) Differential speed. Seldom of importance *as an object of measurement*, but there are instruments for measuring it.]

Theoretically, frequency has no instantaneous value, while angular and linear speeds have; actually, some frequency meters can give practically instantaneous values of cycles per second more readily and more accurately than many tachometers can give instantaneous values of r.p.m. or M.p.h.

The speed or frequency of reciprocating, oscillating or vibrating mechanisms (strokes, cycles, etc. per time unit) is determined by means of (1) a counter (which may count all strokes, or only alternate strokes—those in one direction) *and* a timepiece; (2) a vibration type frequency meter; (3) a stroboscope; (4) a chronograph or oscillograph.

Rotational speed may be determined instrumentally by means of (1) a revolution counter *and* a stop watch or a clock where hours are involved; (2) a "tachoscope;" (3) a "speed indicator;" (4) a tachometer which indicates (and may record) speed *directly and continuously;* (5) a resonance frequency meter; (6) a stroboscope; (7) a chronograph or oscillograph.

Linear speed is calculable from angular speed when the two are associated. Some tachometers, etc., indicate both angular and linear speeds.

This chapter also deals with acceleration, usually defined as the time rate of change of either angular or linear velocity, but here regarded as the time rate of change of speed—speed itself being regarded as one of the industrial conditions as explained above. Acceleration is expressed in (angular or linear) speed units per time units. It is determined indirectly by speed and time measurements, or directly by means of accelerometers. There are on the market both rotational and linear accelerometers.

(b) Classifications

Practical speed measurement and control goes back to the dawn of the steam age, and half a century ago the variety of specialized instruments was already such as to call for classifications in engineering and scientific treatises. Although this chapter is concerned with industrial rather than with laboratory or testing instruments, it is not deemed necessary to depart widely from the schemes devised by the author's predecessors—grateful acknowledgments to whom are hereby expressed:

(1) Chapter V of Griffith's "Engineering Instruments and Meters" published in London shortly after the world war, which still remains a classic though out of date now;

(2) C. Huey's article on "Tachometers, Revolution Indicators, Speed Indicators and Revolution Counters" in the Journal of the American Society of Naval Engineers, August, 1927, which admirably "dissects" those instruments he deals with—including some special marine systems but omitting too many familiar industrial instruments;

(3) The Preliminary Draft of Part 13, Instruments and Apparatus, A. S. M. E. Power Test Codes which appeared in the April, 1929, *Mechanical Engineering* and which Part will constitute a valuable manual when it will be published by the Society; and

(4) The chapter on Measurement of Time and Speed in Diederichs and Andrae's "Experimental Mechanical Engineering," (John Wiley & Sons, 1930), which has also served as a valuable source.

Little need be added, therefore, in the way of engineering data. (No statement made in this chapter must be presumed to express the conclusions of any society or to be in any respect "official" unless it appears as a quotation.) New methods and new types of instruments have made their appearance, however, and in other minor matters, too, particularly when of industrial interest, new data need be set forth.

Two noticeable innovations—the consideration of Frequency and of Differential Speed as forms of speed—require no apology. A third—the inclusion of accelerometers—requires a brief explanation, since they have been omitted from previous treatises on speed measuring instruments: simply that acceleration measurement is a form of speed measurement.

Table XXIV gives, in addition to characteristics, the new classification made necessary because of (1) methods and instruments which have appeared since the previous classifications or which were omitted from them for other reasons; and (2) practical industrial considerations. This classification is based on methods and principles of *measurement*. It therefore starts with the counter and timepiece method which involves the use of two classes of instruments neither of which can measure speed without the other.

The table follows closely what may be called the standard classification which divides all speed measuring methods into five broad groups:

1. Counter and timepiece method;
2. Continuous direct indication of rotatory or linear speed (tachometry proper);
3. Frequency measurements;
4. Stroboscopic methods;
5. Chronographic and oscillographic methods.

Tachometers make up the most important group and were divided by Griffiths into "(*a*) centrifugal force; (*b*) chronometric action; (*c*) magnetic drag; (*d*) electrical similar to dynamo; (*e*) viscous drag." Other authorities also divide them into five to seven classes according to general principle employed, Diederichs & Andrae adding a sixth class, "resonance tacho-

TABLE XXIV—INDUSTRIAL SPEED MEASURING INSTRUMENTS—RECAPITULATION

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CLASS	TYPE	CHARACTERISTICS (Notes below table explain symbols)		
		Optimum Range	Accuracy	Other Characteristics
		Counts p. m.		
Counters	Direct geared—con.	0-1500	Abs.	Pv Av S Sd
	Direct geared—hand	100-3000	dd	Pv Av S Sd
	Cyclometer—con.	0-600	Abs.	Pv Av S Sd
	Cyclometer—hand	100-3000	dd	Pv Av S Sd
	Ratchet—con.	0-200	Abs.	Pv Av S
		R.p.m.		
Tachoscope	Geared counter	200-3000	dt	Pv Av S
	Cyclometer counter	200-3000	dt	Pv Av S
Speed Indicator	3-second engagement	400-20,000	1%	Pv Av S
	6-second engagement	200-20,000	1%	Pv Av S
TACHOMETERS				
Chronometric	Integrating	100-10,000		Pv Co Re
	Conjugating	100-5000		Pv Co Re
Centrifugal Weight	Fly-ball	500-2000	10 r.	Pv (Gr) Inst Co Re T Fr Pn Sd
	Cross-pendulum	500-4000	20 r.	Inf Inst Co Re T Fr
	Tilting ring	500-4000	25 r.	Inf Inst Co Re
	Ball-and-cup	Narrow	0.5%	Pv Inst Co Ind Pn Sd
Centrifugal Fluid	Liquid Cup	Narrow		Pv Co Ind T Pn
	U-tube	10-4000	1%	Inf Co Re Pn
	Liquid pump	Narrow	0.1%	Inf Co Re Sd T Pn
	Pneumatic	dd	1%	Inf Co Inst Re T
Electromagnetic	DC Generator	dd	1%	Inf Co Inst Re RR M
	AC Generator	Narrow	1%	Inf Co Inst Re RR T M
Magnetic Drag	Cup scale	Narrow	Poor	Inf Co Inst Fr M Sp
Viscous Drag	Cup scale	Narrow	Poor	Inf Co Inst Fr T Sp
Positive Pump	Flowmeter	dd		Inf Co Re T
		Counts p. m.		
Inertia	Pawl and wheel	200-2000	Poor	Inf Co Ind Fr
		Cycles p. m.		
Frequency Meters	Induction disk	Narrow	2%	Inf Co Fr Pn
	Reed	Narrow	2%	Pv Co Ind
Vibration Tachoscope	Reed	Narrow	2%	Pv Co Ind
Stroboscope	Glow	"Univ."		Pv S Ind Inst
	Slit	"Univ."		Pv S Ind Inst
Chronograph Oscillograph	} Considered here to be laboratory rather than industrial instruments.			

dd Depends entirely on drive.

dt Depends on time period. Customary to consider $\frac{1}{5}$ second error (1% error in 20 sec.; 0.1% error in 200 seconds, etc.).

Pv Positive measurement principle. (Gr—when gravity; no spring).

Inf Inferential measurement principle.

S Gives single reading each time used.

Co Continuously measures.

Av Measures average speed over a time period.

Inst Measures instantaneous speed.

Ind Indicating only. No recorders on market

Re Recording models available.

RR Remote-reading systems available (beyond limits of flexible shaft).

Sd Suitable for use as Plant Standards.

Sp Measurement based on spring tension.

T Temperature fluctuations affect accuracy.

Fr Friction affects accuracy.

Pn Position affects accuracy.

M Magnetic fields & electrical conditions affect accuracy.

meters," and the A. S. M. E.'s preliminary draft adding "vibration tachometers," "autographic hydraulic pump" and "volume pumpage" to Griffiths' five but lumping his "magnetic drag" and "viscous drag" into one heading "force-drag."

As stated above, this "established" method of classification is followed in the arrangement of this chapter, and Table XXIV does not depart radically from it. But the progress of industrial instrumentation, and the accompanying intensification of the engineering or scientific viewpoint in all industries that use instruments, seem to demand less adherence to orthodoxy or usage, and more of the critical attitude.

It may not be amiss, therefore, to remark that the time seems to have come for a classification according to *just what is directly measured*. Thus, most electromagnetic tachometer indicators are *volt*meters. Similarly, there are pump tachometers in which the measuring instrument is a *flow*meter, itself consisting of a primary device for producing a differential head and of a measuring instrument which is a differential *mano*meter. The heuristic value of such a scheme lies in its analytic effectiveness, making it possible to detect sources of error and complexities. Thus many drag tachometers are discovered to measure nothing but an "effect" the proportionality of which to speed is seldom linear or even calculable for actual instruments. And an elaborate piece of apparatus, far from arousing admiration, may appear in the light of such an analysis to have been built not from a set of shop blueprints but from one of Rube Goldberg's deliciously absurd "Inventions" cartoons. A rough outline of such a classification of *tachometers* would probably start off with two broad groups:

I. Primary Tachometers, namely, chronometric or conjugating tachometers which are the only ones capable of giving a direct reading of (directly measured) revolutions divided by (directly measured) time;

II. All other tachometers.

Extending the same scheme to *all* speed measuring methods and instruments, one arrives by logical steps at a basic division:

I. Positive measurement; and

II. Inferential measurement.

This obviously is *a* basic division. Is it *the* fundamental one? Let us look for a precedent: We have it in the investigations of the A. S. M. E.'s Special Research Committee on Fluid Meters from 1916 when it was appointed to 1924 when it first reported; in its continued work since then; in its resolute stand for the analogous prime classification of all fluid meters into two such functional groups. What if the echoes of the once furious debates on this division have not died out? The very fact that the "positive and inferential" view ran the gauntlet of minute scrutiny before its triumphant emergence enhances its validity as a model for dealing with practically all industrial measuring instruments.

In the light of such a classification, positive speed measurement methods and instruments are those which integrate or conjugate *time and number* or *time and distance*. In addition to the counter and timepiece method, to "speed indicators" and to various chronometric and conjugating tachometers which do not measure instantaneous speed, it includes what we may call the "geometrical" speed measuring instruments, of which a good example is a vertical spindle fly-ball tachometer wholly independent of the action of springs. (Errors due to variable temperature and to variable air resistance can be calculated.) The safest definition of the second group, the "inferential" measuring instruments, is simply "instruments that do not employ positive methods."

Note that this classification does not say anything about measuring "effects" of speed. It implies however that if the utilized effect is not calculable and/or if its measurement is not direct or positive, the principle is "inferential." Another way of putting it is to say that the indications of an inferential instrument are not of speed in the sense (to give a rough analogy) that the indications of a hot wire AC ammeter are not of current but of elongation.

It is necessary to add that just as there are many satisfactorily sensitive, accurate and dependable hot wire instruments that give acceptable results in industry, so do many tachometers that are both "secondary" and "inferential" render excellent service.

An interesting method of general classification is proposed by G. S. Andrews of R. W. Cramer & Co., in a communication just received, the first part of which is inserted here without editing, although its terminology differs from ours, although some assertions are too sweeping, and although some speed measuring instruments do not fall into his rigidly defined "classes:"

The types of speed indicators in use differ considerably; a study of the different types is extremely instructive, and the work accomplished shows great intellectual achievement. On comparing the fundamental principles of all types, it will be seen that they may be grouped into two main classes:

1. Direct Acting speed indicators.
2. Integrating speed indicators.

In addition a small class (3) may be mentioned—Differential speed indicators.

1. The direct acting speed indicators utilize generally the centrifugal force of solid or liquid rotary masses, combined either with gravity or with power of one or several stretched springs, and in this manner measure the angular velocity of an axis revolving proportionately to the speed of the machine on which it is installed. A subdivision of this class is that of the electric types, which depend upon the voltage or frequency generated and are really nothing more than voltage or frequency indicators calibrated in terms of speed. All instruments of this first class possess the advantage of being able to indicate the momentary speeds and conform to rapid changes thereof. But their great disadvantage lies in the fact that they are not accurate for all speeds—most of them not even indicating low speeds. Further, all such speed indicators, having empirical divisions of the dial, must be periodically regulated to enable them in some degree to produce indications which may really be relied upon.

2. The second group (integrating speed indicators) embraces those instruments measuring the amplitude of a movement during a unit of time. The measurement of the speed is being constantly renewed; the instruments necessarily execute the movements which are the absolute consequence of their construction—that is to say, they work *conjugately*. As these movements are accomplished integrally and conjugately, the preliminary setting and subsequent adjustments are eliminated, as are also the serious consequences which may result from the omission of periodical adjustment. The disadvantage of this principle is, however, that only a mean speed during a certain unit of time or distance can be indicated. The quicker the changes of speed, the shorter must be the intervals of time during which the average speed is measured in order that the speed changes may be perceptible to the eye, and (in those instruments which also record on a chart) that a record may be obtained showing as nearly as possible the momentary speeds.

On the one hand, efforts have been directed towards making speed indicators of the first group so perfect that complete reliance can be placed upon them at all times, while on the other hand, the idea has been to perfect speed indicators with conjugate movement so that the indicating and recording units conform as nearly as possible to instantaneous changes of speed. To date, the advantage seems to rest with the second group, in that the best examples of this type have so reduced the time intervals of conjugation (one second) that for all practical purposes the indications of speed are instantaneous. Whereas, the first group, despite great advances in design, are still subject to the basic disadvantage that their calibration is empirical and must be periodically checked and regulated; moreover, they are of necessity subject to external forces, such as momentum, inertia, surge, temperature and other physical forces other than speed. The electric types are, in addition, subject to external magnetic fields. The only advantage of this first group is that owing to the simplicity of

their design they can be produced and sold at prices lower than those of the conjugating type.

3. In the third group of speed indicators, the differential type, the speed determined by a differential train of wheels is compared with a known speed. These instruments possess, however, although in a lesser degree than the majority of speed indicators comprised in the two principal groups enumerated above — the disadvantages of the direct acting and the conjugate movement speed indicators; that is to say, they have neither the conjugate movement, nor do they indicate the momentary speeds. Further, they have a somewhat complicated mechanism.

The usual industrial classification into "indicating, recording and controlling" which is ideally applicable to industrial temperature instruments, for example, seems to require modification here. In the first place there are two distinct classes of speed measuring instruments — those that

Fig. 501

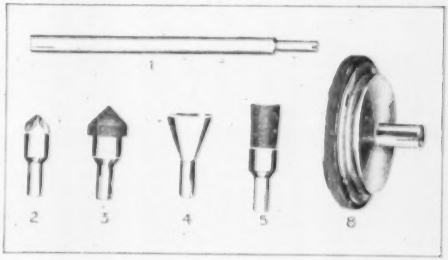

Fig. 502

integrate or conjugate motion and time, and those that give instantaneous speed. In the second place, it is a debatable question whether most speed control devices are instruments at all (see statements as to scope of this Manual in Chapter I, bearing on this very subject, also note at beginning of Section 26 of this chapter).

Another usual industrial classification is into "portable" and "wall" or "switchboard." The small portable speed measuring instruments are called *hand* counters, *hand* tachometers, etc. Fig. 501 shows a typical hand speed indicator (H. H. Sticht & Co.). Permanently installed, self-contained counters are usually called *continuous* counters but permanently installed self-contained tachometers, etc., are usually called *stationary* tachometers, etc. There are also switchboard indicators worked by various forms of remote systems. For almost every imaginable industrial requirement there is at least one make of exactly suitable instrument or combination.

Hand tachometers are generally furnished in a carrying case with an assortment of useful accessories. Fig. 502 shows the set supplied by the J. G. Biddle Co.: "1. Extension bar; 2. triangular steel pin; 3. tip with conical rubber point; 4. rubber-lined funnel-shaped tip; 5. tip with rubber muff; 8. grooved and rubber-tired pulley."

As in other branches of instrumentation, there are available in addition to panel board and other stationary recorders, portable speed recording instruments (which of course are not called "hand" tachometers). These portable recorders are either self-contained or consist of separable elements as in electrical systems.

The stationary speed recorders, too, may be divided into self-contained and remote-recording. Among the stationary self-contained speed recorders on the market are some interesting combination indicating and recording instruments, two of which may be picked out for illustration here as they furnish an instructive contrast: Fig. 503 shows the "Tel" indicator-recorder for automotive vehicles (R. W. Cramer & Co.) and Fig. 504 shows the "American" indicator-recorder for industrial plant applications (Consolidated Ashcroft Hancock Co.).

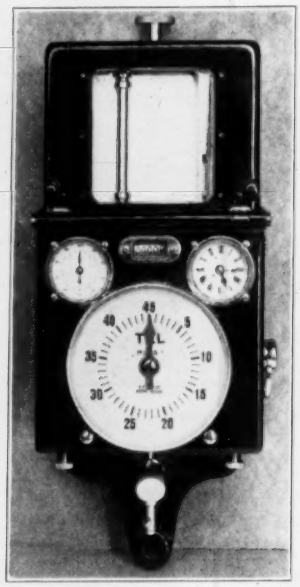

Fig. 503

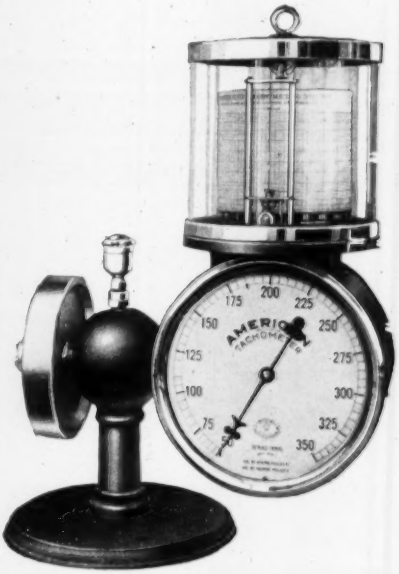

Fig. 504

The switchboard instruments for recording speed electrically are as usual divided into the round-chart and strip-chart recorders. Fig. 505 shows the former and Fig. 506 the latter as supplied by The Bristol Company.

Combination instruments would complicate any method of classification and are not considered in Table XXIV but they are increasingly useful in industry and some representative instruments of this kind will therefore be illustrated and described, under the sections in which the *speed* measuring parts of these combinations belong.

(c) Definitions of Classes

A drawer of catalogs and other commercial literature on speed measuring instruments constitutes incontrovertible evidence that some firms not only fail to adhere to logically descriptive names, but employ wrong terms. This free country naturally and fortunately lacks penal legislation backed by a corps of detectives, stipulating "right" and "wrong" designations of instruments; and while it is regrettable to see terms employed which are apt to mislead engineers whose societies have attached to such terms meanings other than those in the booklets, little can be done about it. But some manufacturers (and some agents of European instrument firms)

not only fail to state in their literature to what classes their instruments belong, not only fail to include in their booklets inside views or schematic diagrams that would convey such information to an engineer, but they do not even supply such diagrams for publication. Some of these instruments may be of superlative excellence but since they cannot be assigned to definite sections in this chapter and since a section on "unknown types" is deemed unnecessary, they will have to be left out.

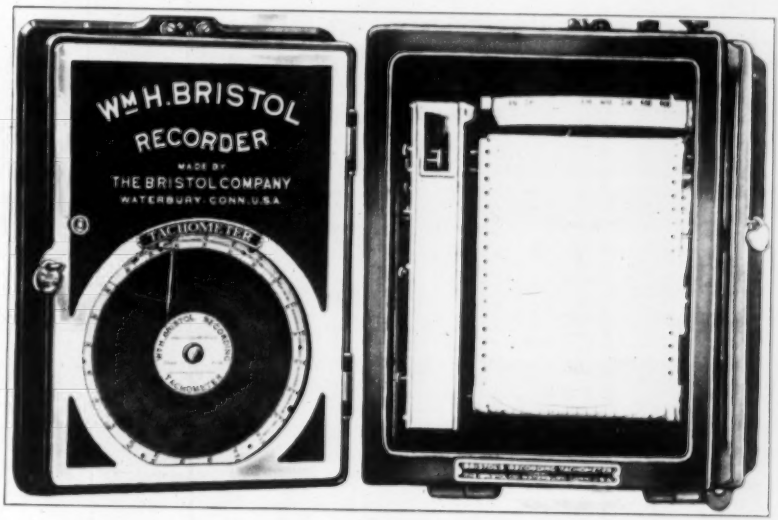

Fig. 505 Fig. 506

Conversely, for somewhat analogous reasons, some classifications—some distinct types—have to be discussed below without the accompaniment of illustrations of actual instruments on the market.

The following definitions are set down only in brief form, and only to differentiate mutually exclusive classes. Other definitions, and of course descriptions, appear further down under the respective section headings.

TACHOMETER. (From *Tachos*, Greek for "swiftness.") An instrument which indicates or records *continuously* the value of *instantaneous* speed. This class includes, however, chronometric and conjugating tachometers which indicate or record average speed over an interval sufficiently brief (usually one second), and which perform this operation in continuous repetition, so that they are not illogically included; also, for the same reason, electrical tachometers employing potentiometers; and, as a rule, all *practically* continuous-measuring tachometers.

TACHOSCOPE. (1) The combination of two instruments—a revolution counter and a *stop*-watch (not *any* timepiece)—arranged to start and stop simultaneously. The reading (from zero in the set-back types, otherwise the increment) is the number of spindle revolutions and must be converted into r.p.m. unless the period during which revolutions are counted is exactly one minute. (2) A vibrating-reed frequency meter operating by resonance and scaled for speed indication. (3) A stroboscope especially designed for speed determination. The *visual* characteristics of (2) and (3) justify the use of the suffix "-scope" in preference to "-meter."

SPEED INDICATOR. The combination into one instrument with one dial scaled directly in rotational or linear speed units, of a counting element and a timing element, so arranged that the instrument will not start until a button is pressed. The indicating hand flies back to zero when a separate button is pressed. Only a single reading (of average speed over a few seconds) is obtained each time the instrument is used, the operation requiring five second or more, depending on type or make.

STROBOSCOPE. An instrument or an apparatus employing the persistence of vision when an object is viewed intermittently. Certain forms are designed for speed determination.

SPEEDOMETER. A combination instrument indicating speed and registering mileage; also furnishing additional indications, integrations and even graphic records in its more elaborate forms (to which trade names are justly and properly applied in preference to "speedometer").

REVOLUTION COUNTER. Self-explanatory.

RPM INDICATOR. Self-explanatory. Preferable to—

REVOLUTION INDICATOR. This term has been used to designate different classes of instruments. It is no longer needed since all these instruments fit into definite classes. It need never be used, and should not be.

TACHOGRAPH and RECORDING TACHOMETER. The distinction is that the former records instantaneous speed while the latter may record at intervals.

CUT METER. A linear speed measuring instrument, usually a continuous indicator of instantaneous speed, of the hand type, equipped with a rubber friction disk for application to the work in a lathe or other cutting machine tool (whence the name) and also provided with a suitable handle facilitating such use.

(d) Industrial Considerations

Apart from the selection of a speed measuring instrument according to its principle—often *before* such selection—the reader will be wise to base his choice on practical requirements, on the answers to questions such as the following:

(1) Is the instrument to be portable or is it to be permanently mounted?

(2) If portable, should it be of the small, light, self-contained "hand" type or does the character or variety of possible uses call for a particular type regardless of size and weight?

(3) If permanently mounted, how driven or connected? Also, from what distance will the instrument have to be read? (Scale length, size of dial, illumination, etc.) Also, would a two-faced or double-dial instrument be preferable?

(4) Will an indicator do or is a recorder wanted? If a recorder, should it produce strip charts or round charts? If strip charts, what width of scale and what speed of travel? If round charts, what size and what period? Any preference for ink records or tamper-proof wax charts?

(5) Is it desired to measure instantaneous speed, average speed or both? Is a counting device required?

(6) Should the scale be uniformly divided or "progressive," with divisions opening up so that readings can be more exact as the speed increases? Note that in fluid tachometers the instantaneous reading of a direct-driven indicating element increases as the square of the speed.

(7) What range? This brings up the question of suppressed zero. In a frequency meter, for instance, a scale from 55.0 to 65.0 or shorter might be specified and an instrument indicating or recording over a scale 0 to 100 would never do.

(8) Is a multi-range instrument preferable? Some reliable hand tachometers on the market can be shifted from one range to another by a flick of the thumb.

(9) Will the instrument have to withstand quick starting strains without injury?

(10) Somewhat along the same line, has the instrument a sufficiently low starting torque? Where considerable inertia must be overcome, flexible shafts are likely to break.

(11) Will the instrument be used outdoors? Will it be exposed to temperature fluctuations?

(12) Will the instrument be handled by trained specialists or by unskilled workers? Also, is it to be read by an engineer or by men who find it difficult to read between plainly numbered graduations?

(13) Is there enough power to drive the instrument without slowing down the apparatus the speed of which is measured, or without a consumption of energy too great under the circumstances? Similarly, will "end thrust" due to applying a contact instrument reduce the speed of the apparatus while measurement is being made?

Other considerations will no doubt suggest themselves, including those of appropriateness and of appearance. As to appropriateness, while various forms of speed measuring instruments could take off the r.p.m. of the propeller shafts of an ocean liner, for example, nothing less than a comparatively elaborate and expensive installation with recorders and counters in addition to large indicating dials located in the bridge house as well as in the engine room would be appropriate. Even on automotive vehicles, appropriateness dictates for a small and inexpensive car a small and inexpensive instrument (which should however combine a wheel drive tachometer with a mileage recorder into a "speedometer") while a large interstate bus should be equipped with a high grade instrument furnishing a plurality of records.

As to appearance, it really takes in some practical factors such as those to be kept in mind when laying out panel boards, and a due regard to convenience and human efficiency, apart from questions of pure taste.

(e) Advantages and Shortcomings

So much depends on the design and construction of individual instruments and remote systems that greater importance should be attached to these factors than to class or type when different classes or types will serve the same purpose. Instead, therefore, of condemning certain types and recommending others, the plan of this chapter is to discuss *characteristics* in describing these types one by one. No instrument is free from characteristic limitations; no instrument is ever placed on the market nowadays unless it can serve some purposes advantageously; no instrument is perfect. Nevertheless, three generalizations are permissible: Other things being

equal, speed measuring instruments should not be specified, the accuracy of which

(1) depends entirely on permanent magnets, or on low-grade clockworks, or on the action of force-measuring springs of dubious origin;

(2) is likely to vary appreciably with temperature, magnetic fields, or other exposure conditions;

(3) is certain to be affected by wear in continuous service.

A fourth generalization is—neither practice false economy nor buy unnecessarily expensive instruments or systems.

Even these general rules are set down hesitatingly, because the author cannot forget obtaining excellent results from instruments called "junk" by other engineers. Some of the strictures laid down in antecedent treatises (all due respect to their authors!) are absurd. The reader will do well to use the foregoing list under (d) as a memo, read up the descriptions below . . . and then let his own inferences and conclusions guide him in his bread-and-butter work involving speed measurement.

2. Standards, Calibrations, Installations etc.

The first part of this section naturally considers only those speed measuring instruments which require calibration and which are so widely used in industry that this section is called for. No need, therefore, of going into the calibration of instruments that measure, for example, such extremely high speeds as radio frequencies—which for that matter are not usually thought of as forms of speed.

A good thing about industrial speed measurement is that the fundamental standards involved are easily reproducible.

For frequency and for rotational speed the fundamental standards are Time and Number.

For linear speed the fundamental standards are Time and Length.

Another good thing is that there can never be any doubt as to "zero" speed.

Calibration can therefore be essentially simple—a matter of zeroing and of checking a number of "points" on the scale—the points to be closer together in the scale region mostly used. This suffices for most industrial purposes and even for precise test work. Where a standard *procedure* assuring the utmost precision is required, that given in connection with pressure measurements in Section 2 of Chapter XI can be used as a guide, containing as it does numerous hints shown by experience to be useful with regard to calibrating other instruments than pressure gages.

Standard of Time Period—Only in scientific work is a registered standard clock necessary. Even a fly-back chronograph is not called for. A high-grade stop watch is a fully acceptable "plant standard" for the comparatively short periods involved in calibrating speed instruments. Note however that the stop watch to be used in the calibration should have been previously calibrated against a pendulum-operated standard clock for several periods of the same duration as those to be used in the calibration. Electric clocks controlled by a master clock are not suitable for such stop-watch calibrations, as a very slight variation in the frequency of the motive current will cause an error in the clock sufficient to be measured by a stop watch

Standard of Count—"Number" is just an ideal fundamental standard, and the actual measurement is *counting*—which operation is subject to personal or mechanical errors. The former can be avoided by the use of counting instruments. The latter are discussed in Section 3 on Counters, and only a counter so designed as to be free from error should be used.

The dependable count of revolutions, and the precise measurement of time period, together constitute the reference standard for any particular value of rotatory speed. Practically, an adjustable instrumental standard is generally employed for calibrating tachometers.

Similarly, in calibrating frequency meters, stroboscopes, etc., the reference standard might be the combination of the actual count of cycles and the measurement of time interval, as by means of an oscillograph; but in industrial calibration practice a comparison instrument is used as the practical standard. See Sections 20 to 23 for precision instruments of various types.

Standard of Speed—The considerations outlined above show that for all practical engineering or industrial tachometer calibration work, a prime necessity is a physical standard of speed, namely, something that revolves at a *known* and *constant* speed, and will therefore cause the spindle of the instrument being calibrated to rotate at the same rate while it is under observation. The most easily obtained device meeting this requirement is an electric motor running at a constant and controllable speed. This speed itself must be measured by a "primary" method. The most convenient such method is the use of a gear-train counter and standardized stop watch. If a gear-train counter is not available, a hand revolution counter can be used if it is driven from the motor in a *positive* manner such as described below under "Instrument Drives." The driving motor should have sufficient inertia so that its speed is undisturbed when the tachometer being calibrated is placed in contact or removed from the end of the shaft, if it is used and calibrated under such method of contact. A fly-wheel is a useful addition—a necessity with a small motor.

(a) Notes on Tachometer Calibration

The tachometer being calibrated may be driven in a manner in accordance with the conditions of use, but the standard or reference counter must be driven by a positive-drive method. If the calibration is made near the operating temperature and close to the time of making the test, the errors due to temperature and changes with time can be largely obviated. Uncertainty in the knowledge of the actual speed is thus reduced to a minimum.

The interval of time chosen for counting the number of revolutions of the tachometer should be at least two minutes, and preferably longer. Readings of less than one minute should not be considered when accurate results are desired. All personal or stop-watch errors introduced in the starting and stopping of the stop watch are multiplied when fractional-minute readings are taken, and will greatly magnify the error when reduced to r.p.m. In readings longer than one minute, such errors are minimized. The greater the number of minutes, the more negligible such errors become.

In making calibrations it is usually more convenient and more accurate to measure with a stop watch the time required for a given number of revolutions of the tachometer than it is to try to count the revolutions in a given period of time.

When the calibration is in progress, great care must be taken in starting the stop watch to see that such starting occurs at the instant when the fastest-moving hand of the gear-train counter passes the zero mark. The same precaution is to be observed in stopping the watch.

At least two readings should be taken for each speed at which the tachometer is calibrated.

For speeds above the range of ordinary counters, a gear reduction should be used. The gears must make a positive drive between the rotating member, the speed of which is to be determined, and the counter.

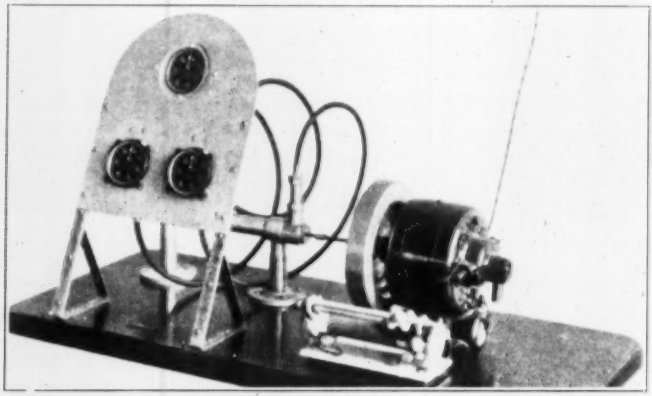

Fig. 507

(b) Calibration Against Continuous Tachometer

Instead of measuring by means of a counter and stop watch the constant speed at which the spindle of the tachometer under test is being driven, a master tachometer may be used.

Such a master tachometer must of course combine minimal limits of error with sensitivity and ease of reading. No particular *type* is advocated: the selection depends on the precision desired in the work and on the range of speeds over which individual tachometers are to be calibrated. Fig. 507 shows one ready-to-use commercial calibrating outfit, as supplied by the Pioneer Instrument Company, in which outfit the master tachometer is of the *centrifugal cross-pendulum* type. Optionally, this company furnishes a master instrument of the *centrifugal fluid* type—the Veeder-Root tachometer described in Section 13. Similarly, the Consolidated Ashcroft Hancock Company advertises that its recording tachometer (Fig. 504) of the *centrifugal "governor"* type is used for the factory calibration of speedometers before shipment.

As recently as 1927, in his *A. S. N. E. Journal* article, Huey condemned for naval service all "designs . . . in which the indications are basically dependent on . . . centrifugal forces." And he is not the only one. But, inasmuch as it is reasonable to assume that calibration service is more exacting than naval service, either these centrifugal master instruments are sold under false pretenses and used by ignorant purchasers, or the condemnation of all centrifugal force types is an unfounded prejudice. It is not difficult to decide which view is right when one considers the Bureau of Standards' use of the Veeder-Root centrifugal instrument. (Of course the Bureau also uses counter and timepiece methods—and others, no doubt—for work of extreme precision not requiring continuous indications of instantaneous speed.)

Time-saving is an important advantage of calibrating against a master tachometer. For that reason, no doubt, this method is employed in production work, a number of tachometers being checked simultaneously along a bench provided with a number of drive shaft outlets. Needless to say, absolute constancy of speed is even more important with this arrangement than the measurement of the constant speed by either the integration of revolutions and time or by the use of a continuous instrument.

Stroboscopic Method—This is a variant of the master tachometer method. The speed of the rotating member which positively drives the spindle of the tachometer under test is determined by means of a stroboscope. Stroboscopes are described in Section 22 where it will be seen that as a rule there are gaps between the various speeds which can be determined exactly. In

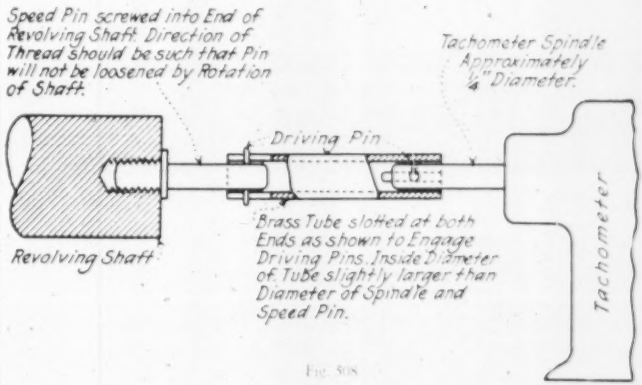
Speed Pin screwed into End of Revolving Shaft. Direction of Thread should be such that Pin will not be loosened by Rotation of Shaft.
Tachometer Spindle Approximately 1/4" Diameter.
Driving Pin
Brass Tube slotted at both Ends as shown to Engage Driving Pins. Inside Diameter of Tube slightly larger than Diameter of Spindle and Speed Pin.
Revolving Shaft
Tachometer

Fig. 508

other words, the "scale" is not continuous. On the other hand, the use of a standard stroboscope, the speed of which can be relied upon, makes it possible to regulate the speed of the spindle of the tachometer under test within extremely narrow limits.

Another advantage of the stroboscopic method is that it can be used conveniently for the calibration of high-speed tachometers in the absence of a high-speed master tachometer.

(c) Tachometer Drives

The following appeared in the A. S. M. E. Preliminary Draft published in *Mechanical Engineering*:

"A Tachometer Drive can be obtained by any one of the five methods, given below. Whenever possible one of the first three should be used.

"(a) Gear or chain. This is a positive drive.

"(b) Flexible shaft or cable enclosed in a flexible housing. This is a positive drive.

"(c) Speed pin threaded into the end of the revolving shaft under observation with a metal sleeve slotted in both ends for a driving link between the shaft and the tachometer. (See Fig. 508). This is a positive drive. Care must be taken to align the tachometer and the revolving shaft properly.

"(d) Adapter on tachometer shaft pressed into contact with a so-called "center" on the rotating shaft of apparatus being tested. Care must be taken to avoid slipping, also to insure that the axis of the tachometer shaft is in line with the axis of the rotating shaft, thereby avoiding eccentricity.

"(e) Belt and friction drive. The use of this method should be avoided as it is unreliable."

This set of stipulations applies, of course, to test work, in which the precision of measurements and their *unquestionability* are of great importance. For many industrial installations of stationary tachometers a belt drive—properly installed and carefully supervised—is found satisfactory, particularly when the power required to drive the stationary instrument is negligible and results in an amount of slip which can be disregarded altogether. (See Section 24 for measurement of slip). Manufacturers of stationary tachometers do not, as a rule, supply belt drive pulleys for instruments requiring positive drives.

Mr. F. A. Amthor of the Amthor Testing Instrument Company which for many years has been designing and installing belt-drive tachometers, has prepared the following résumé for this Handbook:

The belt drive and the friction drive are two dissimilar and distinctly separate drives and should never be classed together. The friction drive was discarded by tachometer manufacturers years ago and is certainly to be avoided as unreliable.

Most tachometers of the governor type are calibrated specifically for belt drive for the reason that this drive naturally complements the governor movement. A tachometer spindle requires so little power to run that the belt in reality merely leads rather than drives it. On belt drives, we specify a special seamless rubberized fabric belt which by its own weight is amply sufficient to drive the pulleys without slippage, even when changing from low to high speeds and at continuous high speeds.

The constant jar, jerk and vibration encountered with many other types of drives is greatly corrected when using belt drive, and in most cases, eliminated entirely. For with belt drive the governor is allowed to act as its own natural flywheel which, working in unison with the natural, uninterrupted drive of the belt, produces an even and unaffected indication and record from which minor speed fluctuations and oscillations due to vibration, jerk, jar, etc. are removed.

On many applications, the only drive we should recommend would be the belt drive as the only efficient drive, and for the reason that with no other drive can the ratio be so freely changed. This change is absolutely necessary in many applications, and is done according to the specific speed range to be covered, the type of machine installation, application, etc.

Most other types of tachometer drives have certain very distinct faults which can be somewhat modified in the design and calibration of the instrument, but which nevertheless cannot entirely be corrected. Over a period of time these faults not only can cause a serious wear and tear on the tachometer movement, but can also greatly affect the accuracy, and cause an unsteady and interrupted indication. Most tachometer troubles in the past have been because these very faults, occurring through an imperfect coordination of tachometer movement and drive, have been magnified and increased over a period of time in use.

For example, the *chain drive* causes a certain jerky movement which can be partly overcome by increasing the size of the sprocket. This increases the linear speed of the chain and with disastrous results. The links produce an uneven hammering vibration which not only causes serious wear but also produces an untrue, unsteady indication.

A *flexible shafting* produces friction inside its own housing even when there is no curve in its line. This friction, together with the continuous wind and unwind of the cable itself, causes a bad, flicking movement of the governor and tends to change the tension of the spring which counteracts the tilting ring.

In *direct connection* with the driving shaft such as on turbine installations, or as directly connected with gears, etc., the governor must sustain a continuous jar, vibration and jerk, caused not only from the starting and stopping of the machine but also when in continuous operation.

There have been certain applications and installations where it has been impractical to use belt drive and where it has been necessary for us to substitute other drives. We certainly do not want to appear as attacking or condemning these drives. But in each case where using a drive other than belt, we have had to specifically construct and calibrate the tachometer for the particular drive used. In certain cases when using these drives, we have had to include special damping devices to eliminate the undue minor interruptions and fluctuations, and have had to sacrifice a certain sensitivity of indication.

A tachometer is not a stock and standard instrument to be made on production basis and kept in stock. Every element such as application, installation, speed range, desired sensi-

tivity, drive, etc. must be taken into account in the construction and calibration. Each tachometer represents an individual special job.

Throughout this discussion, we have been talking of the governor type tachometer only.

Drives for Special Purposes—In addition to the standard fittings generally supplied with hand tachometers, etc., there are fittings made up for various special purposes. Fig. 509 shows a double-groove pulley for measuring the speed of threads and yarns (Herman H. Sticht & Co.). One groove has a

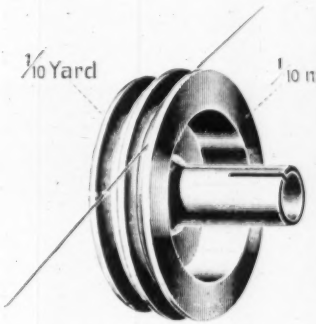

Fig. 509

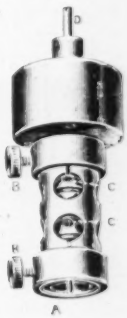

Fig. 510

circumference of one-tenth meter, the other of one-tenth yard, so that when the thread passes around the one, the instrument is read directly in meters per minute; with the other, in yards.

For measuring speeds either above or below the range of any particular instrument, the gear box shown in Fig. 510 is listed by the Coats Machine Tool Co., Inc. If, for instance, the lowest reading obtainable is 30 r.p.m. this can be reduced to 15 r.p.m. with the use of a 1:2 reduction box. Available gearings are as follows: Reducing—1:4, 1:3, 1:2, 1:1½. Multiplying—4:1, 3:1, 2:1, 1½:1.

(d) Notes on Taking Readings

In measuring the speed of slow-moving machinery it is necessary to time only one or a few revolutions and record the result (the period) in seconds per revolution or per stroke. This may then be converted to the frequency in revolutions (or strokes) per minute. Care should be used in measurements on slow-moving machinery to include exactly one or (preferably) more *complete* revolutions, as a small fraction of a revolution in slow rotation may introduce a large percentage error when calculated to r.p.m. It is best to use a rotating part for reference rather than to note the time from the end of a stroke of a reciprocating member, since the exact end of the stroke is often difficult to determine.

When measuring speeds of 600 r.p.m. or more, a positive drive between the revolving shaft under observation and the speed-measuring instruments should be employed. The slippage of any contact device, such as a sharp pointed or rubber-tipped instrument spindle, introduces an error of unknown magnitude.

When the drive is secured by an adapter on the tachometer spindle pressed in contact with the center of the rotating shaft, the axis of the

tachometer spindle should be in line with the axis of the rotating shaft. In using this type of drive in connection with light machinery, particular care should be taken, as the end thrust due to pressing the tachometer spindle into the shaft center may reduce the speed materially.

When using a flexible-shaft drive, ample time should be allowed for the shaft to wind up before taking a reading of the speed-measuring instrument. The instrument should not be read during the period that the flexible shaft is retarding due to slowing down of the revolving shaft under observation, or due to the disconnecting of the flexible shaft. At low rotative speeds and for short periods of observation, errors of considerable magnitude will occur if these precautions are not observed.

In taking linear speeds with the rubber-disk fitting, be certain (1) that sufficient pressure is exerted to prevent the rubber friction disk from expanding under centrifugal force sufficiently to produce an error due to increasing the effective radius of the disk; and (2) that excessive pressure does not reduce the effective radius.

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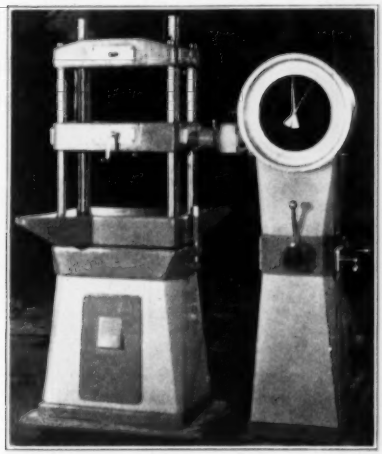
New Precision Hydraulic Universal Testing Machine

(Riehle Bros. Testing Machine Co.)

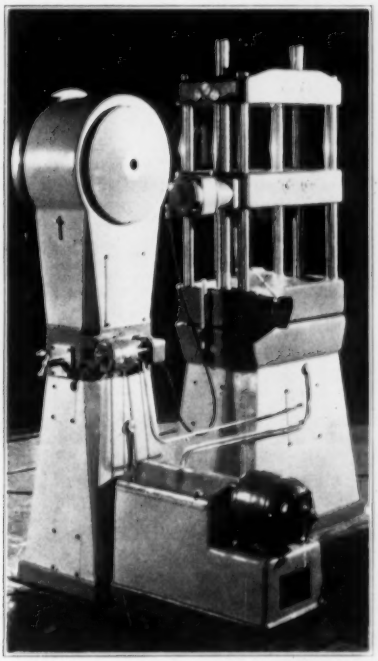
The machine is built in three distinct units; the Loading Unit, the Indicating Unit and the Power Unit.

Loading Unit—This part of the machine has the customary upper and lower heads in which are the grips for tension testing. The upper head rests on four rods attached to the table while the lower head is sustained by two large screws set into the base of the machine. Bronze nuts in this lower head, rotated by a motor and worm drive, serve to move the head up or down for adjustment. This drive is never used for testing.

The table is supported on the ram, which with its cylinder is housed in the base casting. When hydraulic pressure is applied to the ram it lifts the table and with it the upper head.



Above—View from front of operating side.



Right—Rear view, showing the Power Unit.

As the lower head is stationary, it is evident that a specimen gripped in the upper and lower heads will receive a tensile load while one placed between the table and lower head will be loaded in compression. The ram and cylinder are ground to a fit of such precision that no packing is required to hold the pressure.

A slight leakage maintains a film of oil between the surfaces of the ram and cylinder and practically eliminates friction. The hydraulic pressure in the cylinder is, therefore, a function of the load on the specimen and affords an accurate and dependable means of measuring that load.

The Gripping Mechanism—The gripping mechanism is claimed to be the most striking innovation in the loading unit of the machine. The grips themselves are of the familiar

wedge type, but where the usual type grips must be moved up or down to seize the specimen, these grips move horizontally until they engage. Where the specimen is strained they then slip on inclined surfaces as in the usual type, so as to maintain their hold on the specimen.

Gripping and releasing is accomplished by turning a small crank handle. *No liners are required and no part of the mechanism extends above or below the head.* Changing of grips can be done in little over a minute.

As to the grips themselves, they are, as stated previously, of the familiar wedge type but with certain notable improvements. A new form of serration has been developed and all grips are machine cut—"V"'s as well as Flats.

Weighing Unit—Pressure from the main cylinder is brought through a transfer valve so that it may be applied, at the will of the operator, either on one plunger working singly or on two plungers working in opposition. These plungers are also of the unpacked or floating type and are oscillated rapidly by an individual motor drive so that friction effects are entirely eliminated. Whether one plunger is working alone or both plungers opposed, the resulting effort is counterbalanced by the buoyant effect of a steel float in a pool of mercury.

The sizes of the float and of the mercury containera re so chosen that a small motion of the float produces a relatively large change in the mercury level. This results in a very sharply marked equilibrium point which not only makes for accuracy but also completely prevents surging in the event of rapid change of load.

When the single plunger is working, the hydraulic pressure on its cross-section area at one-fifth the total capacity of the machine is sufficient to submerge the float its full depth. When the two plungers are working in opposition it requires the full capacity pressure to submerge the float its full depth. This arrangement obviously affords a simple and direct means of obtaining full scale load indications either at full capacity or one-fifth capacity as desired.

The travel of the float is transmitted through a rack and pinion to a pointer moving across the face of a twenty-inch dial. The pointer actuating mechanism is very simply and ruggedly constructed.

Owing to the relatively large forces employed in the float assembly we find it possible to use heavy construction in the indicating mechanism without any loss in sensitiveness, thus insuring long service with little or no maintenance cost. The dial face itself is graduated and marked for both full and fractional scales so that both are always available. Changing from one to the other involves only the manipulation of the transfer value which can be accomplished in a few seconds. A maximum pointer is provided and the whole dial face closed by a plate glass cover to protect the dial and pointer from injury.

The indicating unit, in addition to its primary function, serves as a mounting for the necessary electrical and hydraulic controls. Immediately under the dial is the single pump control lever. This enables the operator to regulate the flow of oil with the utmost sensitiveness and accuracy. On the left side is the push button station controlling the pump motor and immediately adjacent to it is the double throw switch for running the lower head up or down. On the right is the transfer valve for charging the load indicating scale and immediately above it is the knob for adjusting the pointer to zero.

Power Unit—This is located directly in back of the weighing unit. The pump is a six-plunger variable stroke high-speed pump mounted in the oil tank and driven by a constant speed motor through a chain transmission. The flow of oil is continuous and regular without pulsations. The delivery is regulated by a cam, operated by the control levers on the front of the weighing unit, which adjusts the stroke as desired. When in the "off" position, a further motion of the cam opens a discharge valve which permits the load plunger to return to its starting point.

All oil entering the pump passes through a filter which effectively prevents the entrance of dirt or chips into the system.

New Gage for Large Holes

(*Taft-Peirce Manufacturing Company*)

A VERY simple, accurate, adjustable flat plug gage for measuring large holes (Style 9042) offers both speed and accuracy in gaging such work.

The gaging member may be expanded by means of an eccentric adjustment, locked and then can be reground to original size. This tool adds to the accuracy, light weight and convenience of the old type solid gage, the economy of adjustable gaging members.

These members are interchangeable, made from alloy steel, and can be furnished separately for replacement, thus insuring practically unlimited service.

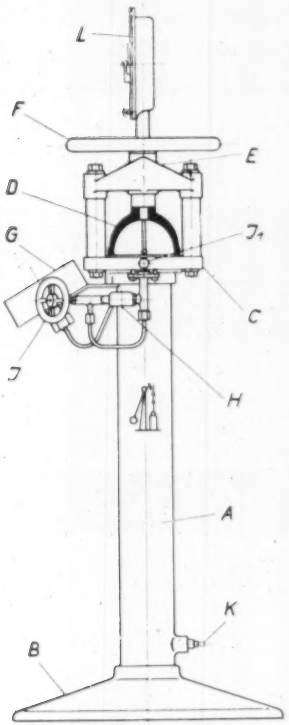
Supplied for internal diameter above $2\frac{5}{8}$". Expansion of $\frac{1}{8}$" is provided, allowing a generous number of regrinds.

Shopper Dalén Bursting Strength Tester

(H. Z. Schniewind)

THIS apparatus is intended for determining the bursting strength properties of paper cardboard, tissues and all other kinds of ductile materials in sheet form. The principle of the test is to subject a circular area of the test sample to the force exerted by compressed air until it bursts. The amount of air-pressure required to burst the sample is measured and the coefficient of bursting strength is registered in lbs./in.² or in kg./cm.²

As shown on the illustration the apparatus consists of a cylindrical hollow standard *A*, forming at the same time the air container and mounted rigidly on a heavy circular foot plate *B*. Clamping table *C*, bell-shaped clamp *D*, hinged cross bar *E* and handwheel *F*, bursting strength gage *G*, air pressure gage *H*, test pressure valve *J*, pressure release valve *J*, inlet valve *K* and convexity measuring device *L*.



The air container is solidly connected with a heavy circular foot plate, which affords a reliable stand of the apparatus. It holds a quantity of air sufficient for many tests. The container is filled by means of a double-action hand pump supplied with the apparatus.

Special attention has been devoted to the design of the clamping arrangement. In order to allow perfectly reliable clamping, the bell-shaped clamp is mounted on a cross bar. The square thread screw runs in a long bushing and both the screw and handwheel are of substantial dimensions. An elastic intermediate bed is provided between the lower clamping surface and the bed plate. This elastic bed serves the purpose of evenly distributing the pressure exerted by the handwheel, thereby insuring a uniform grip through the annular clamping surface, it also obviates damage to the sample. To avoid loss of compressed air on test specimens of great permeability, a thin rubber diaphragm is placed between the sample and the lower clamping surface. This diaphragm is held securely and in such a position that the test body is subjected to an even stress over the whole of its area from the moment the test starts. The bell shaped clamps are interchangeable. The change can be effected readily by simply loosening one nut on one of the stays of the cross bar: the other stay being in the form of a hinge, the whole top part can be swung clear away from the table.

For testing paper, clamps of the following sizes are used:

a) Metric Standard 10 sq. cm.
b) Inch Standard, test area as specified for Mullen Tester.

For cardboards and tissues the standardized testing surface is 100 cm.²

As the degree of expansion in paper, cardboard, tissues, fabrics varies considerably, special clamps must be used for the different materials. Bell-shaped clamps are made—

for paper, metal foil, etc. with a depth of 20 mm.
for cardboard and similar material with a depth of 60 mm.
for tissues, skins, etc. with a depth of 60 mm.

The pressure gage registers the bursting strength with full accuracy. It is provided with a drag indicator which allows the reading of the maximum pressure after the termination of the test. For accurate zero adjustment of the gage the dial is so constructed that it may be revolved by turning a knurled screw fitted to the casing. A standard pressure gage is provided for measuring pressures up to 10 kg./cm.² (140 lbs./in.²). For testing tissue paper, cigarette paper etc., of a low bursting strength, a pressure gage more highly sensitive than that for the ordinary papers is required. For this purpose a pressure gage indicating bursting strain up to 1 kg./cm². (14 lbs./in.²) is used.

A second pressure gage is provided to indicate the air pressure in the cylinder.

Following a suggestion by Prof. Dalen, a special instrument was designed for measuring the height of convexity formed by the sample before bursting.

This special instrument has a contact point resting lightly on the center of the sample under test. When the sample, under the effect of pressure, begins to bulge, the contact point is lifted and its movement is transmitted on a measuring device, where the height of convexity is shown by a pointer on a circular graduation. For paper this measuring device is supplied to measure a bulge up to 20 mm. height, for cardboard, textiles and other materials of great ductility, it is provided for a range from 0 to 60 mm.

From the bursting strength and the height of bulge the mean breaking load in kilograms relating to a strip 1 cm. wide, and therefrom the breaking length in km of any strip may be calculated.

By reason of its important function, i. e. to provide a means for determining with accuracy the height of convexity of a sample at the bursting moment, this instrument forms a valuable supplement to the Bursting Tester.

Pneumatic Cycle Controllers

(Bristol Company)

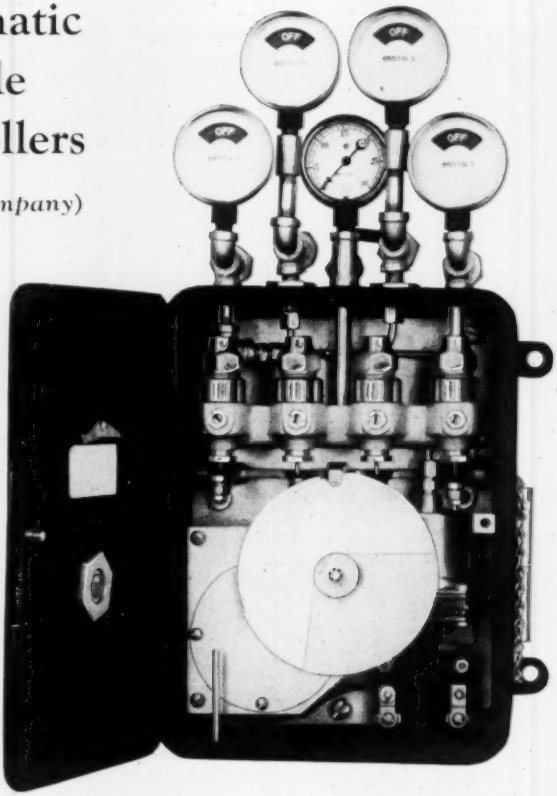


Fig. 1

IN the automatic control of process cycles the maximum of simplicity at a minimum of cost may generally be obtained by the use of diaphragm-operated valves actuated by a pneumatic cycle controller. A very large proportion of controlled processes are such that the sequence of the several events which terminate the cycle is the reverse of their order at the beginning of the cycle. Where this condition holds, the operations may be controlled by a single-cam instrument, in which a number of pilot valves are actuated in turn by a motor-driven cam. This cam may be made adjustable within certain limits; and speeds are determined by change-gearing between the synchronous motor and the cam-shaft. The starting and stopping of the motor are usually governed by a pressure-operated switch within the case of the instrument. A single-cam controller is shown in Fig. 1.

Where utmost flexibility is required, and the different events in the cycle overlap by varying degrees, rendering control by a single cam impracticable, there is available the type of instrument shown in Fig. 2. Here several individual cams are mounted on a common shaft, and each is adjustable through a wide range, both as regards the duration of its influence in the cycle and its position in the sequence of events. The pneumatic features of this instrument are identical with those of the single-cam controller; but, as in the instrument illustrated, two pressure switches may be furnished, where it is desired to associate the starting and the stopping of the motor with different events in the cycle.

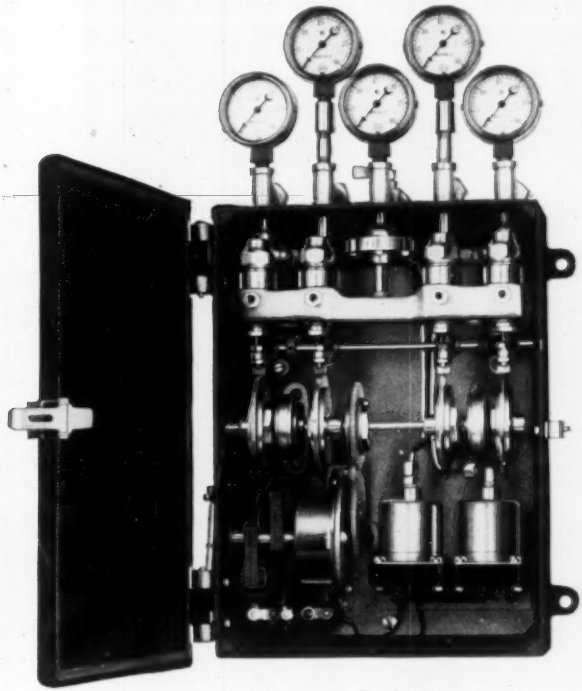


Fig. 2

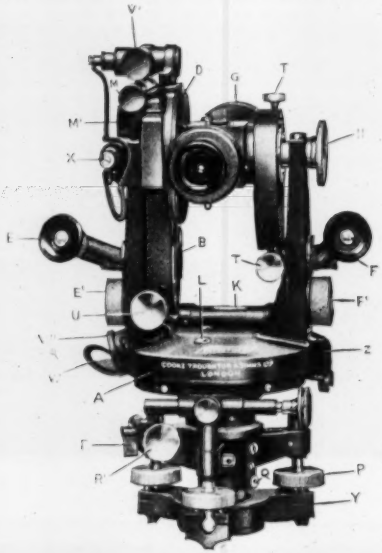
The instruments described do not perform the function of regulation; but they may be used in conjunction with any of a variety of pneumatic or electrical regulating devices for pressure, temperature, etc.; and, with suitable accessory equipment, they readily lend themselves to those types of control where a certain degree of interlocking is required.

Automatic cycle control finds a wide application in the processing of foods, in the manufacture of articles from rubber and plastics, in textile and paper mill practice, in the operation of presses and molds, and, in fact, in any industrial process where it is required that valves, or mechanisms which can be made subject to the control of valves, are required to be operated in a more or less definite sequence.

"Tavistock" Transit Theodolite

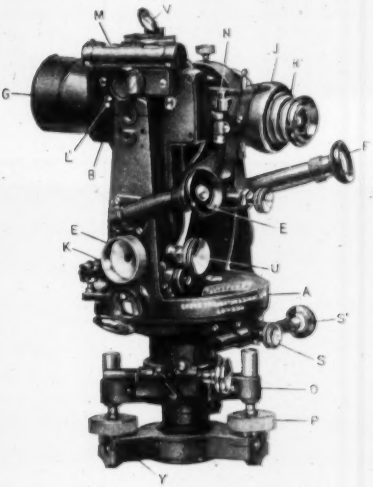
(*Cooke, Troughton & Simms, Ltd.*)

THE particular feature of the method utilized (patents of Captain T. Y. Baker, R.N., and R. W. Cheshire, Admiralty Laboratory, National Physical Laboratory) is a bisection setting, thus following to some extent usual micrometer practice, in which two movable webs are brought into a symmetrical position in relation to a circle division. In the "Tavistock" Theodolite, however, the images of two diametrically opposed graduations of the circle are, by optical means, brought on either side of a fiducial mark in a suitable field of view. Both applications of this method of reading depend on the great sensitivity of the eye in judging the equality in width of two slightly separated light gaps. The act of symmetrically straddling these two lines about the reference mark gives a meaned circle reading free from centering errors. The width of the light gap on either side of the black reference band can be varied to suit the taste of individual surveyors by a simple adjustment.



A Cover-plate enclosing optical system whereby horizontal circle is read.
B Box enclosing optical system whereby vertical circle is read.
C Horizontal circle.
D Vertical circle.
E Eyepiece for reading vertical circle.
E¹ Milled head for setting vertical circle micrometer.
F Eyepiece for reading horizontal circle.
F¹ Milled head for setting horizontal circle micrometer.
G Object glass.
H Focussing head for telescope.
H¹ Screw-focussing eyepiece.
J Cover to adjusting screws for graticule.
K Plate spirit level.
L & L¹ Screwed caps allowing access to adjustments in (A) and (B).

M Altitude spirit level.
M¹ Prism reader for altitude spirit level.
N Zero-setting adjustment for vertical circl
O Tribrach.
P Footscrews.
Q Connection for leads from battery.
R Clamp for lower plate.
R¹ Slow-motion screw for lower plate.
S Clamp for upper plate.
S¹ Slow-motion screw for upper plate.
T Clamp for telescope.
T¹ Slow-motion screw for telescope.
U Setting screw for altitude spirit level.
V Reflector for illuminating vertical circle..
V¹ Electric illumination for vertical circle.
W Reflector for illuminating horizontal circle
W¹ Electric illumination for horizontal circle.
X Bright-field illumination to telescope.
Y Trivet stage.
Z Clamping faces for magnetic compass.



The ordinary method of engraving lines on a silver inlay breaks down, for various technical reasons, when applied to small circles reading direct to single seconds or less. Therefore, a new technique has had to be evolved, entailing the use of glass circles, the divisions being marked on the rear face, which is silvered over and suitable protected. Thus the surface bearing the circle graduations is out of the reach of dust and deposited moisture, and cannot be tarnished. Moreover, such division lines are absolutely permanent, and stable. The use of glass circles is especially advantageous when artificial illumination is required.

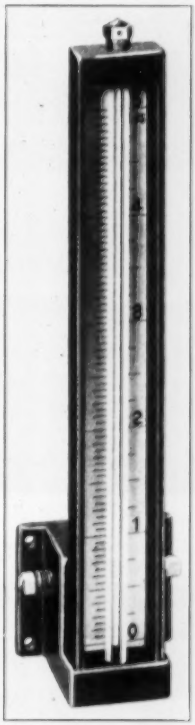
As to accuracy, given good average outdoor conditions, the uncertainty of reading for a single observation with the Tavistock Theodolite would not be expected to exceed 4 seconds.

while testing these instruments under workshop conditions on collimators, free from the disturbing influences of air currents, refraction troubles, etc., it is found to be easily possible to keep within 2 seconds with a single observation. The foregoing figures include graduation, pointing, personal and all other sources of error.

So much for the great accuracy realizable with these small optical theodolites, but to many minds an equally great, if not greater advantage (especially when the subject is viewed from the economic standpoint) is the increased speed and comfort with which readings can be made. Recently four officers of a British Government Survey Department, without any previous experience of the Tavistock instrument, were able to observe with it at once at a speed of about one pointing per minute. To achieve anything like the same accuracy with the older type of theodolite would, in all probability, have taken nearly three times as long.

Mercury Column Pressure Gage

(Amthor Testing Instrument Co.)



THIS type is particularly recommended for all applications requiring the accurate and close measurement of low pressures and vacuum. Outstanding features in the design are the following:

Protected glass and scale—The glass tube is protected from possible breakage by the U-shaped scale case.

Distinct clear reading—The mercury level stands out sharply against the white backing of the glass tube. The depressed black graduations and figures against the smooth aluminum finish of the scale present a clear and distinct reading, easily visible from a distance. All other parts are finished in heavy black enamel.

Universal 3-way connection—Any one of the right, left or top connections on the mercury chamber can be used. All three are threaded for ¼" standard pipe thread.

Continuous Blow-off Hydrometer

(Permutit Company)

EVERYDAY boiler plant practice shows that for a given boiler design and set of boiler operating conditions there is a maximum saline concentration beyond which steam of good quality will not be obtained. It is customary to use a hydrometer to determine this saline concentration or density (which is a measure of the concentration of dissolved salts). But the hydrometer reading varies according to the temperature of the liquid (a change of only 5 deg. F. is equivalent to a change in concentration of about 100 grains of salts per gallon). This means reading temperatures and making corrections with the aid of complicated tables, or perhaps waiting for the temperature of the boiler saline to reach the exact point for which the hydrometer is calibrated.

To overcome these difficulties the boiler blow-off hydrometer has been developed. With this hydrometer it is possible to read temperature corrections directly in terms of density.

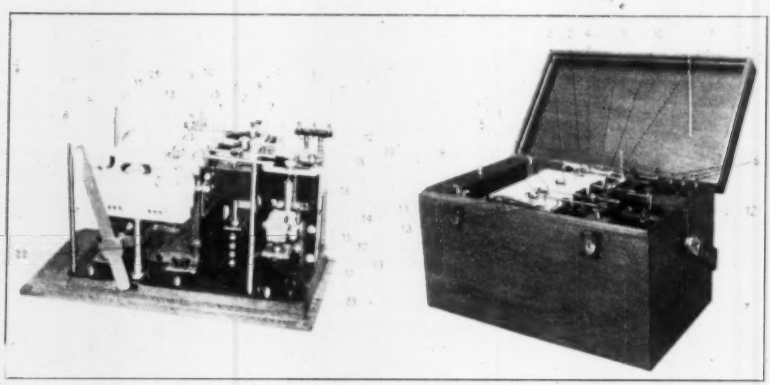
An integral thermometer placed in the bulb of the instrument makes it possible for the operator to make the correction readily and instantaneously.

Miniature Portable Universal 3-Component Vibration Meter

(Anglo-Swiss Electrical Co., Ltd.)

THIS instrument is primarily intended to give a chart record of the vibration and shocks occurring on locomotives and rolling stock. The instruments can be adjusted to record to any desired scale from full size to twice full size.

The instrument comprises 3 independent miniature seismographs, each of which records one of the three components. When the instrument is suitably placed, one horizontal component records the vibration in a longitudinal direction, i.e. along the longitudinal axis of the



train or vehicle, and the other records vibrations at right angles to the longitudinal axis. From the records of the vibrations in the 3 planes at right angles it is possible to determine the movement as a whole of the spot where the vibration meter is mounted.

The weight (14) for the vertical component is mounted on one end of an arm (15) the other end of which is free to move about a horizontal pivot. The arm is carried by a spring (16). Attached to the front end of the arm (15) is a second arm which projects downwards and terminates in a disc working in an oil dash-pot (17), which effectually damps the natural oscillations of the weight. The vertical movements of the weight (14) are transmitted to the pen arm (3) by a simple system of levers (18).

For each of the 2 horizontal components the inactive weight is mounted on the vertical edge of a thin rectangular plate, which is hinged like a door about the other vertical edges. Each of the 2 plates is completely enclosed in a box filled with oil, (19) and (20), for damping purposes. The movements of these 2 plates are transmitted to the pen arms (1) and (2) in the same way as for the vertical component.

The outstanding feature of this instrument is the powerful air and oil damping of the components, combined with very low friction. By virtue of the special damping, it is possible with this instrument to obtain a faithful record of the severe shocks which occur in traction work, without any danger of resonance. At the same time, owing to the small amount of friction present, the instrument will record accurately vibrations of relatively small amplitude, and each of the pen arms has a well-defined zero position.

Any desired scale between full size and twice full size can be obtained by adjusting the length of the pen arms.

In addition to the three pen arms recording the three components, two further pen arms are provided. These arms (4) and (5) are actuated by small solenoids and are intended for drawing time lines on the chart. The arms (4) and (5) can be controlled either by a contact chronometer or by hand key, and the leads from the 2 solenoids are brought out at the terminals (6). Neither chronometer nor hand key is normally supplied with the instrument, but a 4½-volt dry battery is mounted in the case for energizing the solenoid.

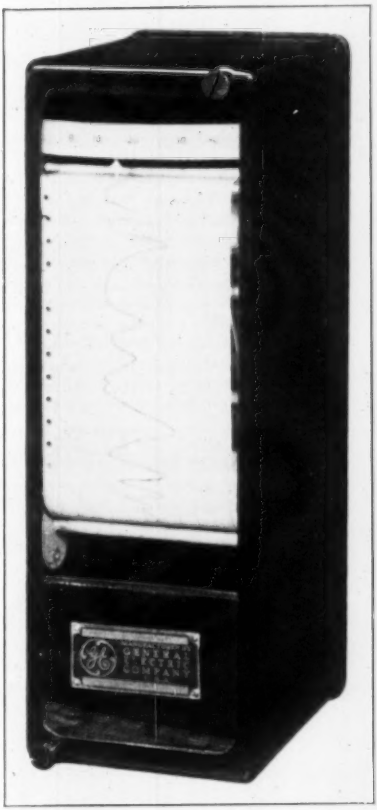
All 5 pens record in ink on a common chart (21) the effective width of which is 150 mm. The chart is driven by the clock (22), the latter being wound by means of the ratchet lever (8). Two ranges of chart speed are provided, the first being from 70 to 300 mm. per minute, and

the second from 140 to 600 mm. per minute. When using the instrument with a high chart speed the ink has not sufficient time to dry, and therefore a plaster roller is fitted which automatically dries the chart and prevents smearing.

The complete instrument is contained in a portable oak case fitted with leather carrying strap and measuring 440x250x260 mm. Only the baseboard (23) is seen in Fig. 1.

Photoelectric Recorder

(General Electric Co.)



RECORDING instruments such as voltmeters, ammeters, etc., have always been less sensitive than corresponding indicating instruments, the result of the mechanical burden placed upon the instrument by the recording pen. The inertia of such a weight has made it impossible for a recording instrument to respond as quickly or to as small a change as could an indicating instrument.

Now, by the application of a different principle, the General Electric Company has produced recording instruments of increased sensitivity and accuracy. By incorporating photo-electric and phiotron tubes, in recording instruments, it has been made possible to record quantities where only a limited amount of energy is available.

In the photoelectric recorder the inking pen is driven by a small high-torque element supplied from an auxiliary source of energy. Directly beneath the recording element is an indicating instrument element that is operated by the quantity which is to be recorded. A photoelectric circuit and an optical system of special design cause the recording element to follow the indicating element and make a continuous record of the deflection. In this manner any quantity which may be indicated can also be recorded.

The only mechanical burden placed upon the indicating element is a tiny galvanometer mirror. For ordinary applications, miniature indicating instrument elements are entirely satisfactory, and result in a minimum energy requirement from the circuit which is being measured. The instruments can be of the most sensitive types.

The photoelectric circuit and optical system represent a distinct departure from past practice. Errors due to ordinary variations in supply voltage, photoelectric and phiotron tube characteristics, lamp intensity and other variables usually troublesome in such circuits have been practically eliminated. The filaments of the various tubes are operated at voltages well under their rating, insuring long life.

The energy taken from the measured circuit is extremely small, being only that amount necessary to operate the indicating element. Recorders can readily be constructed with a full-scale deflection of 20 microamperes, at which current the power requirement from the measured circuit is less than one microwatt. On the other hand, there is no upper limit to the rating of the indicating element; the recorder is adapted to almost any type of service conceivable in measurement work.

The recorders now available can be obtained incorporating practically any of the General Electric indicating instruments.

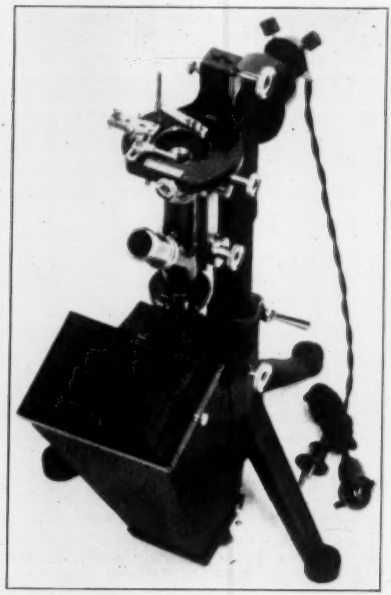
Metallus

(*Clay-Adams Company, Inc.*)

THIS new metallographic microscope constructed on the Le Chatelier principle, combines the principle of the inverted metallographic microscope with the ease and convenience in handling of the usual type without in any way affecting the optical advantages.

The Metallus combines subjective observation with photographic equipment in a new and different construction; the entire apparatus including the photographic equipment is mounted compactly on a firm tripod base, eliminating the usual extended optical bench and can be set up in a space 14" square.

It is claimed that the best possible arrangement for metallographic photography is thus attained, as the observer can examine the specimen through the ocular, focus the image on the ground glass and take the photograph, without changing position. An important additional feature is the ease with which specimens can be projected on a table or screen. Projection is invaluable for convenient examination by an individual or group. It eliminates the eyestrain of microscopic examination.



Source of Light—A special filament lamp of 6 and 7 volts, 5 ampere provides a steady non-flickering illumination, and can only be used with a rheostat. The rheostat may be used on direct or alternating current and on 110 or 220 volts by connecting the current with the respectively indicated terminals on the rheostat. The apparatus may be connected either on the 6 or 7 volt mark (as indicated on the rheostat) depending on the illumination desired; 6 volts are suitable for subjective observation whereas 7 volts giving more brilliant illumination should be used in projecting and for micro-photography. A switch is mounted in the connecting cable to turn the light on and off. The lamp is completely mounted in a lamp housing on a sliding bracket, along which it is moved to secure the best illumination. By means of centering screws on the outside of the lamp housing the light rays are further adjusted to the aperture of the objective. For most effective centering of the lamp, care should be taken that the spiral filament of the lamp lies parallel to either one of the lamp filament. Condenser lens is optically correct and fixed at the foot of the lamp housing.

Light Filter—Between the transverse tube and the condenser is a revolving disc containing six light filters.

Transverse Tube—The light equipment lies in a horizontal plane with the vertical illuminator and is connected by a transverse tube. This transverse tube contains a lens system and 2 iris diaphragms. The diaphragm next to the light filters, is used to adjust the illumination to the various objectives and kinds of observation. The lever controlling the diaphragm moves along a calibrated scale indicating the size of the aperture. The second diaphragm is used as an auxiliary means for adjusting the light rays in the vertical illuminator, and also controls the light rays so as to exclude all unnecessary light from reaching the objective, thereby obtaining greater depth and clearness. Between the 2 diaphragms is a mechanical correction device operated by a screw at the right side of the apparatus.

Vertical Illumination is situated beneath the objective at the junction of the vertical and transverse tubes and illuminates the object by means of either a triangular mirror or a triangular plane glass which are arranged so that either one may be applied. For high magnification, table or wall projection, the mirror reflector is to be preferred as it gives a strong brilliant light reflection whereas in lower magnifications and photography the plane glass reflector should be applied as for this work it gives a subdued light, more suitable for examination through the ocular, and micro-photography. If the knob located directly underneath the

stage on the left is in normal position, the mirror reflector is in use. To use the plane glass reflector pull out the knob to its stop limit. This knob is also intended as a correction screw for any appearing shadows or uneven illumination in the field. The vertical illuminator is held in place by a set screw and should not be removed unnecessarily.

Stage is situated above the tube and the objective. The object is placed upon it with its prepared surface above the aperture facing the objective. It has a large aperture 50 mm in diameter for the examination of larger objects. The aperture may be suitably reduced by the insertion of diaphragms (which are made of a glass plate with metal ring). Three diaphragms are supplied with the apparatus to adjust the aperture to 35, 25 or 15 mm. The object is kept in position by means of a clamp with 2 spring pins attached to a small vertical rod in the stage. In applying or releasing the spring clamp, handle it at end connected with the vertical rod. The stage is also constructed with a mechanical calibrated cross moving device, operated by means of micro-screws. The range of the compound motion is 30 mm. each way. Two calibrated position bars are attached to the stage and are adjustable. These devices enable recording of any desired point on the object so that it can easily be relocated.

Coarse Adjustment screw is on the right and moves the stage with the object. A locking screw is also provided on the opposite side so that even a heavy object may be placed on the stage. After bringing the object in approximate focus the locking screw is applied preventing the weight of the object from pressing the stage downward.

Fine Adjustment—The fine adjustment screw moves the tube. The screw may be operated from either side of the apparatus, one side being provided with calibrated scale.

Objectives—Special achromatic objectives are supplied, corrected to a tube length of 250 mm. for use with uncovered objects and give a clear and faultless image. They have short mounts which bring the back lens of the objective as close as possible to the vertical illuminator whereby clear and uniform illumination of the object is obtained. The objectives are all of desirable slip on mount type, facilitating quick interchange.

Oculars—Any standard ocular of either the Huygenstan or compensating type may be used.

Ocular Observation—An oblique tube is extended from the vertical tube for ocular observation, the image being reflected by a mirror which is located at the junction of the 2 tubes. When the extension of the oblique tube is down to its stop limit, the mirror is in position reflecting the image into the oblique ocular. When projecting through the main vertical tube the extension of the oblique tube should be pulled out to its stop limit. Both ocular tubes are of standard size and will take all standard microscopic eyepieces. For observation through the oblique tube a dark filter is supplied and should be attached to the outside of the ocular to protect the eyes from strong and brilliant light rays.

Photographic Equipment consists of a strong metal housing mounted on the lower part of the stand with a reflecting mirror at the bottom and a hooded ground glass for convenient observation at the top. The vertical tube with an ocular at the lower end projects the image on to the reflecting mirror which in turn reflects it on the ground glass or plate. The ocular at the lower end may easily be exchanged by swinging the apparatus sideways after loosening the lever at the right side of the stand. A photographic shutter for various exposures is built into the vertical tube.

Table or Wall Projection—The apparatus is swung away from the camera box by releasing the lever on the stand and may be raised vertically to increase the distance and size of image for table projection. For wall projection a projecting prism, supplied with the apparatus, is attached to either the oblique or vertical ocular. Proper adjustment of the light source is essential for effective projection and for screen projection; most satisfactory results are obtained in a dark room.

Photoelectric Tube makes it Possible to Locate Airport in Fog Flying

IT is possible for the photoelectric tube, or electric eye, to "see" an airport or airway beacon in spite of a fog so heavy that the human eye cannot help the aviator, it was announced by W. F. Westendorp of the General Electric research laboratory, in a talk before the Dayton (Ohio) Engineers' Club on May 5. Apparatus for so locating airports in heavy fogs, either in daytime or at night, was exhibited and demonstrated by Westendorp, who is carrying on the work of light studies made by Dr. Langmuir, associate director of the laboratory.

Those who have driven an automobile through a fog appreciate how difficult it is to judge distances of oncoming headlights, and how hard it is to see the road through the glare caused by one's own headlights. The fog, contrary to general opinion, does not absorb light but

disperses it—instead of traveling in straight lines from the light source to the eye, the light rays are deflected and reflected between the particles of moisture in the air, so that the light is thoroughly dispersed and is traveling in all directions by the time it has gone a little distance from the light source. The result is that the human eye can not see the light source, but is aware only of a possible general increase in brightness of light, depending on the nearness and intensity of the light source.

The photoelectric tube, sensitive to slight differences in light intensity and capable, with the assistance of other vacuum tubes, of converting such light intensity changes into electric current variations which can be greatly amplified and put to work, has been made into an airport beacon finder.

Back toward the tail of the plane there is mounted a large photoelectric tube. In front of it is a mirror, mounted at a 45° angle and rotating at about 100 R.P.M. so that the mirror rapidly reflects light from windows on opposite sides of the plane to the photoelectric tube. Two instruments on the instrument board in front of the pilot are remotely connected to the photoelectric tube and its amplifying unit. The first instrument measures comparative light intensities on the opposite sides of the plane; the second measures absolute intensity of the light. The first shows whether the airport light is to the left, right or directly in line with the nose of the plane; the second shows whether the aviator is approaching or going away from the light. The human eye would be unable to notice any differences in the amount of light through windows on opposite sides of the plane, but the photoelectric tube determines even slight differences. Since the fog so thoroughly and uniformly disperses the light, the amount of light reaching opposite sides of the airplane differs according to the direction of the light source.

If the photoelectric tube responded to all kinds of lights, it would be useless, since city lights and similar sources would affect the instrument. The pick-up device in the plane, therefore, has been tuned to respond to light flickering at the rate of a thousand times a second. Light with such a flicker cannot be obtained if using an incandescent or arc light since the light impulse would merge, but can be obtained by using 1000-cycle pulsating current with a hot cathode neon tube at the airport. The neon tube is definitely lighted and unlighted a thousand times a second, and while the bright red neon light appears to the human eye to be without a flicker, the photoelectric tube recognizes the difference between this and other lights, and signals accordingly. The device has not been brought out commercially.

"Crescent" Tape-Rule

(Lufkin Rule Co.)

A 6-FOOT measure, combining in a unique way the convenience of a pocket tape and the utility of a rule, is known as the "Crescent" Tape-Rule. It is an accurate steel tape that automatically winds into sturdy case only 2″ in diameter, yet, when withdrawn, is rigid like a rule. "Crescent" No. 696 is marked inches to 16ths; No. 696D is marked feet, 10ths and 100ths of feet, i. e., engineers' measure. It is handy to use and easy to carry in the pocket. It can be used by the mechanic, engineer, architect, contractor, factory superintendent and inspector.

The line or rule blade is of super quality tempered steel, stiffened by special forming. It is nickel plated and has prominent dark markings. Unsupported, it may be projected like a rule. It will also flex around and accurately measure circular, round-cornered and other shaped objects. Measurement is taken when outer end is projected against any object, and the solid clip at first end serves for withdrawing rule blade from case and also as a hook for taking measurements out of arm's reach. The sturdy case is chromium plated, and has smooth-working, spring-winding device, with ratchet stop.

The operation of the "Crescent" Tape-Rule is simplicity itself, exactly same as any spring-wind pocket tape. It is never dangerous, for the rule blade being manually withdrawn, automatically returned, is always under control. It cannot fly out of case at a high and unrestrained speed. Simple pressure on push button recoils it in case far more quickly than any rule can be folded.

A New Optical Pyrometer*

A RECENTLY developed cross-filament pyrometer of Siemens & Halske is based on a principle not previously used and is especially suitable for fast and accurate temperature measurements between 90° and 1800°C. A characteristic of the new instrument is its extremely low weight of about 1.5 lbs. which excludes fatigue of the hand even at extended use. The cross-filament pyrometer is, just as the familiar glowing filament pyrometer, a partial radiation pyrometer the action of which as is known is based on the comparison of the brightness of the body to be measured with the brightness of a calibrated incandescent lamp at a definite incandescent color which is filtered through a red glass. The simple construction, however, could only be realized by the application of a new measuring method. The incandescent lamp contains 2 crossed glowing filaments of materials of different characteristics of current-brightness. The 2 current brightness characteristics intersect at a definite temperature which serves as a comparison temperature (Fig. 1). The 2 filaments of the lamp and an adjustable resistance are connected in series to a little flash-light battery (Fig. 2). Before the measurement, the comparison temperature is adjusted by means of the resistance; this is attained when the 2 filaments appear equally bright. By means of a gray-wedge between objective lens and lamp the radiation of the body to be measured is then attennated so much that body and cross-filament appear equally bright that is that the picture of the cross-filament disappears in the picture of the

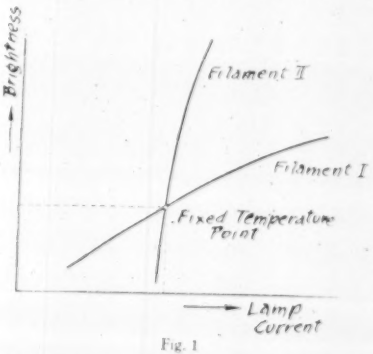


Fig. 1

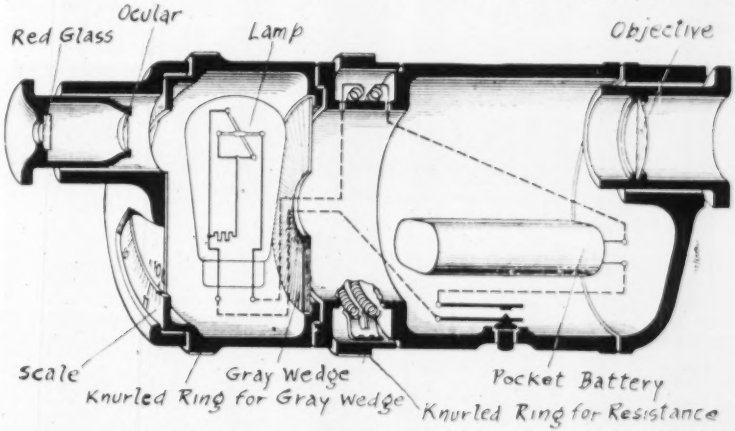


Fig. 2

radiating body. The gray-wedge is provided with a division in °C on which the temperature can be read. This measuring method makes an accurate measurement without an electrical indicating instrument possible. In order to facilitate the adjustment of the 2 filaments to equal brightness one of the filaments is shaped as a broad ribbon so that it acts as background for the other round wire filament. The adjustment is made without difficulty with an accuracy of about 3° which results in a very high accuracy of the instrument. The differences at the lowest range (900°C.) amount to about ±2-3°, at 1600 to 1800° to ±8-10°; they are therefore rather small for a portable control instrument. The telescope-shaped housing in which all parts are mounted is made of a pressed material. The instrument can be adjusted equally well and easily at large and small distances. The new cross-filament pyrometer is a reliable measuring instrument which can constantly be carried around by the

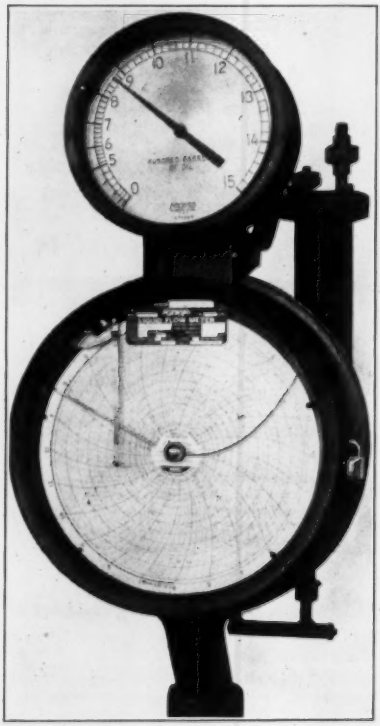
*Translated from Die Messtechnik, April, 1931, pages 113-114.

operating engineer. It has already proved its value in the temperature measurement of metal and steel melts, rolling of material, forging of pieces, annealing and hardening, furnaces of all kinds, burning of ceramic materials, glass melting, etc.

Recording, Integrating and Indicating Flow Meters

(The Foxboro Company)

Application—The Foxboro Recording, Integrating and Indicating Flow Meter is designed for use on processes in which it is desirable to have a flow meter which can be read easily and instantly. In a gas plant or power plant, for instance, it is often necessary for the operator to open a valve which is at a distance from the meter and at the same time watch the meter to see how the flow is being affected. On applications like this, and also in boiler rooms wehre there is a multiplicity of instruments to be read, the 8-inch indicating scale on the Combination Meter gives a highly visible reading at all times. In addition the Meter furnishes the highly desirable and well-known recording and integrating features. This instrument gives the operator the complete story. A glance at the indicator gives him the instantaneous reading of the flow. By reading the integrator, he can obtain the total flow for the period of operation and the chart gives him the record of the entire operation. Only with these three aids can the operator control the process intelligently.



Construction—This instrument is similar in construction to the standard Foxboro Flow Meters. It has a standard 12″ round case on top of which is mounted an 8″ Indicator. This indicator is attached to the recorder case by a special casting through which the actuating link runs. The dial of the indicating instrument has the long, open, concentric scale, plain tapered pointer and block numbers which have made Foxboro Indicating Gages and Thermometers noteworthy for their ease of reading. The dial can be cut to indicate the rate of flow in any desired units. The entire assembly is completely closed and is so designed that it is dust and moisture proof. The 12″ case which contains the recording and integrating features has the standard ring with rubber gasket and the indicating gage has a threaded ring.

Operation—Measurement of velocity, and hence rate of flow, when measuring liquids, can be secured by making use of the orifice meter principle, i.e., by placing in the pipe line an orifice of smaller diameter than that of the pipe, a greater velocity will result at the orifice than exists in the line. The same princip'e may be applien in measuring the volume of gases, when the pressure is constant. The increase in velocity through the orifice causes a drop in pressure on the downstreamside of the orifice, and this drop or differential pressure furnishes a measure of the flow. All Foxboro Flow Meters make use of this orifice principle for operation. For a complete description of the orifice principle see our handbook, "Principles and Practice of Flow Meter Engineering." The only difference in operation between a standard Foxboro Meter and the Combination Meter is in the new indicating scale. The indicator is actuated by a link which extends through a hole in the casting which connects the two cases and attaches to a lever on the pressure-tight bearing of the recorder.

A String Oscillograph and Recording Camera

By

John D. Crawford*

FOR a number of years the General Radio Company has been manufacturing a string-type oscillograph in which the shadow of the vibrating string is thrown onto a translucent screen by means of a multi-sided rotating mirror. By adjusting the speed of the mirror it is possible to view the wave shape of recurring alternating-current phenomena.

To further enhance the usefulness of the oscillograph a unique moving film camera has been designed. This camera uses standard 35 mm motion picture film or paper at speeds up to 30 inches / second. The arrangement of the apparatus is shown in Fig. 1 on which the path of the light beam has been indicated. Light from a 32-candle power headlight bulb passes from the lamp house at the extreme right through a lens system in the string galvanometer. Instead of passing on through the viewing box, the beam, (shown by the dotted lines) is deflected by the mirror into the camera. A cylindrical lens serves to concentrate the beam. The mirror is mounted on a vertical shaft fitted with stops. A twist of the wrist is all that is necessary to shift its position so that the light beam is reflected into the camera or allowed to pass unimpeded into the viewing box. The operation is similar to that of a Graflex camera.

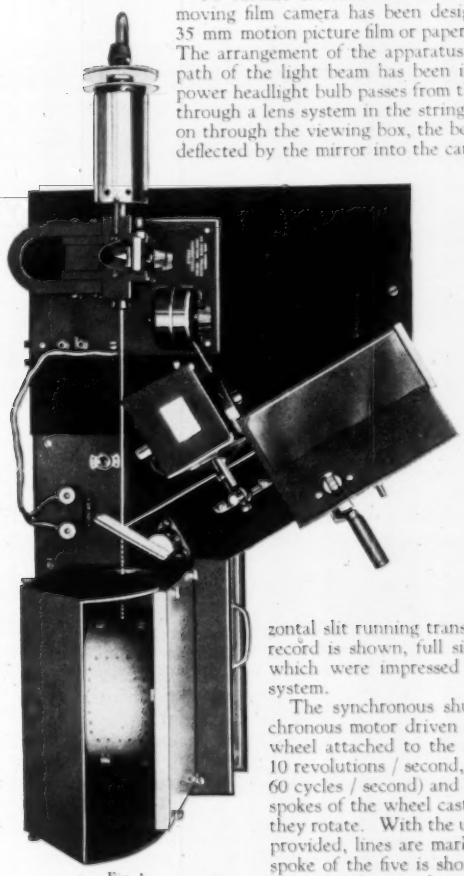


Fig. 1

The camera itself consists of a rectangular aluminum casting having 3 separate compartments. The lower compartment on one side serves as a magazine for the unexposed film. This film passes over a driving sprocket and through a light-tight slit into the upper compartment which serves as a magazine for the exposed film. As the film passes up over the driving sprocket it is momentarily exposed through a horizontal slit running transversely across the film. A typical record is shown, full size, in Fig. 2, the vertical lines on which were impressed by a synchronous-shutter timing system.

The synchronous shutter consists of an enclosed synchronous motor driven from the 110-volt line. A spoked wheel attached to the shaft rotates at an exact speed of 10 revolutions / second, (if the supply frequency is exactly 60 cycles / second) and the shutter is so mounted that the spokes of the wheel cast a shadow along the camera slit as they rotate. With the use of the five-spoke wheel normally provided, lines are marked in 0.02 second intervals. One spoke of the five is shorter than the others, thus marking 1/50 second intervals on the film. The synchronous shutter also provides a means for indicating one-second intervals, the square white spot in the lower right-hand corner of Fig. 2.

This string oscillograph and camera combination is notable for its ruggedness, low first cost, and low operating expense. For this reason it has had a wide acceptance in the labora-

*Engineer, General Radio Company.

tories and electric rooms of schools and colleges for the ease of replacing strings when broken by student use has been an important factor.

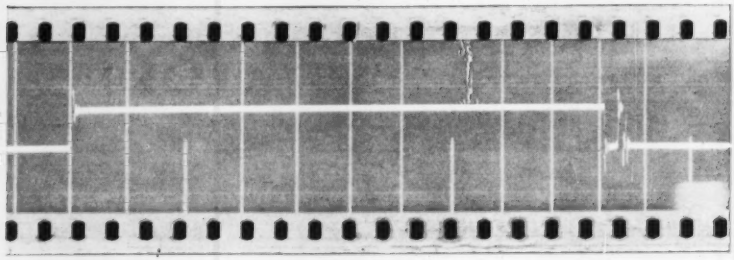
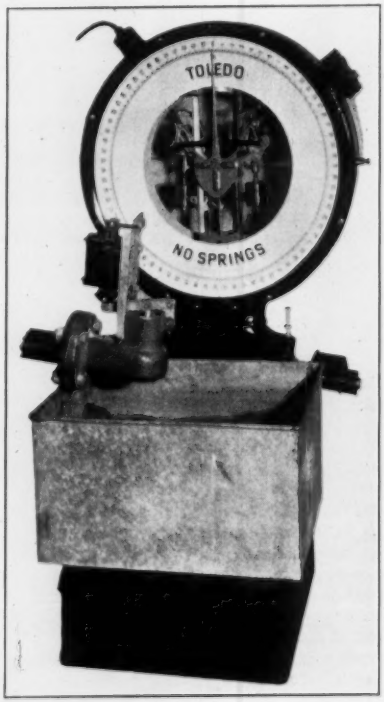


Fig. 2

The instrument is adapted for any kind of oscillographic work where the maximum frequency is below 3,000 cycles / second. With microphone pickups generally available the instrument also becomes useful for studying sound impulses produced by small moving mechanisms such as clocks and watches or of vibrations in heavier machinery.

New Solenoid Valve

(Toledo Precision Devices, Inc.)



A SOLENOID dripless valve has recently been perfected which stops all dripping after the valve is closed.

The valve operates on the solenoid principle; that is, when the current is on, the valve is open, and when the current is broken the valve closes. The valve seat is placed at the outlet, so that no liquid can flow after the valve is closed.

With this valve, exact measures of any liquid are possible as the flow can be instantly stopped. It was designed primarily for use with the Toledo Scale Electric Cut-Off Weighing Device.

With this attachment the liquid passes through the valve and flows into a container on the scale. As the container fills, the weight of its contents is automatically registered on the scale dial by the indicator. When the indicator reaches any predetermined weight it passes over the electric eye, intercepting a beam of light, automatically cutting off the current thus stopping the flow through the valve.

This valve may be used to advantage in any filling operation where exact wieghts are essential. This new device will be found extremely valuable for use in oil refineries, bakeries, ready mixed concrete plants, by paint manufacturers, lard renderers, and in fact, in any liquid packaging or mixing operation. It comes in ½", 1" and 2" sizes.

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INDICATING CONTROLLER. Broadside describing and illustrating indicating control instrument for automatically controlling relatively high temperature processes and units such as glass furnaces, galvanizing tanks, etc. Brown Instrument Co., 4482 Wayne Ave., Philadelphia, Pa.

HEATERS & HOT PLATES. Bulletin 31-A describes the stand-up-ability, convenience and efficiency of Precision Electric Heaters and Hot Plates. Precision Scientific Co., 1736 N. Springfield Ave., Chicago, Ill.

BAKELITE REVIEW. Vol. 3, No. 1 of this periodical contains the following articles: "Color," "Save the Surface with a Bakelite Finish," "Picking the Man," etc. Bakelite Corp., 247 Park Ave., New York, N. Y.

TYCOS ROCHESTER. The April, 1931 issue of this quarterly contains the following: "New Things in Weather Science," "Finding the Right Climate," "Cashing in on the Accuracy of Old Man Weather," "Sliding Show," etc. Taylor Instrument Companies, Rochester, N. Y.

RECORDERS. Circular 8700f-G describes and illustrates temperature recorders for generator rotors and stators. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

THE GRAPHIC. No. 431 of this publication is entitled, Graphic Instruments as a Guide in the Operation of Large Machines. Esterline-Angus Co., Indianapolis, Ind.

DRAFT GAGES & MANOMETERS. Bulletin No. 28 describes and illustrates combination draft and pressure gages for reading furnace draft on top incline tube and boiler draft on lower incline tube and wind box pressure on the vertical pressure tubes on forced draft chain grate stokers. Bulletin No. 33 describes furnace draft, boiler, draft and wind box pressure suited for any type of fuel, such as oil, gas or coal. Bulletin No. 38 describes U gage manometers used for reading pounds and ounces, inches and tenths of pressure. Defender Automatic Regulator Co., 308 So. Eighth St., St. Louis, Mo.

PRESSURE DEVICES. Bulletin No. 70 describes and illustrates power type pressure devices for remote master pressure indicators and recorders and other uses. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

GAS ANALYSIS. A reprint from July 15, 1929 issue of the Analytical Edition of Industrial and Engineering Chemistry entitled, "An Improved Air-Gas Ratio Apparatus" by Crandall Z. Rosecrans. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

TRU-VAC GAUGE is the title of a small folder on the Tru-Vac Gauge which indicates vacuum conditions instantaneously and continuously. Continental Electric Co., St. Charles, Ill.

RADIO INSTRUMENTS. Catalogue F, Part 2, is a comprehensive supplement to part 1 of catalogue F and describes all new instruments and announces important specification changes in others. General Radio Co., Cambridge A, Mass.

PYROMETERS. Catalogue No. 1101 features a new line of potentiometer pyrometers. This catalogue contains 48 pages and is profusely illustrated. Brown Instrument Co., Wayne and Roberts Aves., Philadelphia, Pa.

GAS SERVICE JOURNAL. May, 1931 issue of this publication contains the following: "Measurement of Load Division in a Distribution System;" "New High Pressure Gas Supply to Maryland Towns of Ellicott City and Cockeysville;" "Coke Oven Gas as a Source of Chemical Raw Materials," etc. Pittsburgh Equitable Meter Co., Lexington Ave., Pittsburgh, Pa.

RECORDING GAGES. 24-page Bulletin 168 is devoted to the new steel spring recording pressure gages. Foxboro Co., Foxboro, Mass.

FUEL OIL VALVES. No. 50 Bulletin describes hand operated oil fuel regulating valves. Automatic Temperature Control Co., Inc., 34 East Logan St., Philadelphia, Pa.

RECTIFIERS. 16-page Circular 1907 describes Mercury-Arc Rectifiers, includes many photographs and drawings. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

RECORDING METERS AND GAUGES. Publication No. 150 entitled W & T Tanner Remote Recording Meters and Gauges. Wallace & Tiernan Products, Inc., Belleville, N. J.

ARRESTERS. Circular 1737-F entitled "Advance Guards" is a 23-page, illustrated publication describing autovalve arresters and the correct method of installing them. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

RESISTANCE BRIDGES. A folder which describes and illustrates resistance bridges for various purposes. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

NAVIGATION INSTRUMENTS. Four booklets dealing with the following: Oil Level Gage, Telepoint Compass, Aircraft Compasses and Navigation Lights. Pioneer Instrument Co., 754 Lexington Ave., Brooklyn, N. Y.

TAPE-RULE. A leaflet describing and illustrating the Crescent tape-rule that automatically winds into a sturdy case only 2 inches in diameter, yet when withdrawn, is rigid like a rule. The Lufkin Rule Co., Saginaw, Mich.

MONOCHROMATIC LIGHT. A card describing and illustrating a nephelo and absorptiometer for monochromatic light. P. J. Kipp & Zonen, Delft, Holland.

RECORDERS & THERMOMETERS. One 4-page circular describing the Tapalog pyrometer recorder with synchronous electric clock power, and the other describing the Model 8501 recording electric thermometer, null method type. Wilson-Maeulen Company, Inc., 383 Concord Ave., New York.

TEMPERATURE CONTROL. Five new folders: Cir. 243-P "Better Galvanizing," Cir. 249-P "Better Chemical Processing," Cir. 271-P "Better Heat-Treating in R. R. Shops," Cir. 281-P "Better Ceramic Products," Cir. 288-P "Better Gas"—through better temperature control. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

CHRONOFLITE. Leaflet describing a new precision instrument of that name incorporating in one case, a stop watch, an elapsed-time watch and an 8-day clock. Jaeger Watch Co., 304 East 45th St., New York.

THE FOG HORN. The June, 1931 issue of this publication contains the article, "Defects in Rayon Goods," by Herbert R. Mauersberger. Parks-Cramer Company, Fitchburg, Mass.

THERMOCOUPLES. A leaflet describing and illustrating vacuum thermocouples for measuring weak alternating currents. P. J. Kipp & Zonen, Delft, Holland.

RECORDERS. Cir. 254-F describes a wall type electrical thermometer which measures at one central location as many different temperatures as are required. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

SLITTING SAWS. A small circular describing metal slitting saws with side chip clearance for deep slotting with free cutting action. Brown & Sharpe, Providence, R. I.

GAGE. A leaflet describing and illustrating the height gage used to measure depths easily and accurately—relative differences in height are determined quickly. Brown & Sharpe, Providence, R. I.

BALANCES. A circular describing the improved model short beam analytical balance No. 414m in brass case. Julian H. Becker, Delft, Holland.

BAUSCH & LOMB MAGAZINE. The feature article of the June, 1931 issue is "How Many Lenses in a Pot of Glass," and technical article is the "Red-Green" Test. Bausch & Lomb Optical Co., Rochester, N. Y.

COMBUSTION. Catalogue 11 entitled "Efficient Combustion" describes CO and CO_2 recorder. Industrial Combustion Engineers, Ltd., London, England.

RAINFALL RECORDER. A four-page circular describing the Stevens Type A-30 rainfall recorder that will run a year with one setting. Leupold, Volpel & Co., 267 Washington St., Portland, Ore.

PYROMETERS. A four-page folder printed in blue, silver and black describes new potentiometer pyrometer, is well illustrated and shows nine of the fifty novel features. Brown Instrument Co., Wayne and Roberts Ave., Philadelphia, Pa.

THERMOMETAL. A 16-page booklet describing Wilco thermometals which are duplex or bimetals, two metals with different rates of thermal expansion permanently bonded throughout their contact surfaces. The H. A. Wilson Co., 97 Chestnut St., Newark, N. J.

THE LABORATORY. Vol. 4, No. 3 contains the following articles: Benjamin Rush, Teacher of Chemistry; A New Hand Refractometer; A New Balance; The Hickman Vacuum Still; Chlorine, in Industry and in the Laboratory; New Hyperthermometers. Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.

MAGNETIC CLUTCHES. "Keeping Pace With Machine Design" is the title of this new 24-page C-H publication on magnetic clutches. Cutler-Hammer, Inc., 12th and St. Paul Ave., Milwaukee, Wis.

EXPERIMENTER. Vol. V, No. 11 contains the article, "A Continuous-Film Camera for the Oscillograph" by Horatio W. Lamson, and Vol. V, No. 12 contains "Electron Oscillations" by Eduard Karplus. General Radio Co., Cambridge A, Mass.

OFFICE & FACTORY. Attractive booklet with ingenious "floor" pages showing the home office and factory with its various departments of the Pioneer Instrument Co., 754 Lexington Ave., Brooklyn, N. Y.

CONTROL INSTRUMENTS. The 48-page Catalogue No. 8008 is devoted to automatic control applied to various industries, recording controllers, indicating controller, valve mechanisms and control panels, etc. Brown Instrument Co., Wayne and Roberts Aves., Philadelphia, Pa.

TEST EQUIPMENT. A loose leaf folder containing descriptions and photographs of different test equipment with their prices. Pioneer Instrument Company, 754 Lexington Ave., Brooklyn, N. Y.

SURVEYING INSTRUMENTS AND FIELD EQUIPMENT. Catalog No. 28 describes transits, levels, rods, range poles, plumb bobs, tapes and field supplies. Brandis & Sons, Inc., 754 Lexington Ave., Brooklyn, N. Y.

WATER WORKS JOURNAL. The May, 1931, issue contains the following: "The Water Works of the City of Pittsburgh, Pennsylvania;" "Associated Improves Water Service on Long Island;" "Hydraulically Speaking," etc. Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, Pa.

SAND TESTING EQUIPMENT. Catalogue No. 102 is a loose-leaf reference book on sand testing and foundry control equipment and also for sand data. Harry W. Dietert Co., 676 W. Grand Blvd., Detroit, Mich.

AUTOMATIC OSCILLOGRAPH. Leaflet 20521 describes and illustrates Type PA Automatic Power Oscillograph. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

LIGHTNING ARRESTERS. Leaflet 20365-A describes autovalve lightning arresters for the protection of railroad signal apparatus. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

SHIP PROPULSION. Publication S. P.-1814 is devoted to modern ship propulsion and an exposition of successful installations. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

GENERATORS. Leaflet 20452-A includes several photographs and a drawing describing vertical water-wheel driven alternators. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

ENGINEERING & SURVEYING INSTRUMENTS. A 64-page catalogue identified as Seventh Edition devoted to Sterling transits and levels. Warren-Knight Co., 136 North 12th St., Philadelphia, Pa.

INDUCTION MOTORS. Leaflet 20385-A, Type CS, Squirrel Cage Induction Motors, describes the new W-frame motor, which has interchangeable mechanical and electrical parts. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

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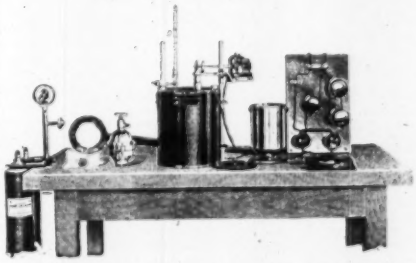

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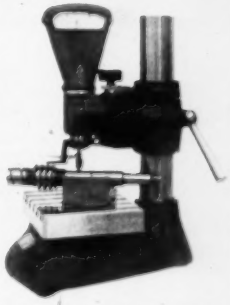

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Abstracts on instruments and devices for measurement, inspection and control

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PHYSICAL TESTING

Dilatometric Investigations in Binary Magnesium-Aluminum Alloys in the Cast State (Dilatometrische Untersuchungen an binären Magnesium-Aluminium-Legierungen in gegossenem Zustande). Willi Claus & S. Breisemeister. Hauszeitschrift der V. A. W. und Erftwerk, Vol. 3, Jan.-Mar. 1931, pages 40-53.

This investigation was undertaken primarily to discover relations between shrinking dimensions and heat expansion coefficients for pure aluminum and Mg-Al alloys. The diagrams of state are discussed and anomalies of solidification explained. The methods for the measurements of expansion are described, the results illustrated in numerous micrographs and equilibrium conditions of texture discussed. A direct connection between shrinking and expansion cannot be stated. There are 16 references and 2 appendices, one giving the numerical values of shrinking dimensions and expansion coefficients, the other describing an apparatus of quartz-glass for determining the expansion coefficients at high temperatures.—Ha.

Friction Coefficients of Lining Materials of Automobile Dry Clutches (Versuche zur Ermitttlung des Reibungskoeffizienten von Belagmaterial trockenlaufender Automobilmotorenkupplungen). Dr. Florig. Die Messtechnik Vol. 7, No. 1, Jan. 1931, pages 11-13.

From the Institute of Automotive Vehicles at the Technische Hochschule, Dresden. Describes fully a test arrangement for measuring the friction coefficients as function of the pressure between materials, of slip, and of temperature. Results in short are: the friction coefficient of motion reduces somewhat with increasing pressure, the coefficient of rest increases somewhat. With increasing slip the friction coefficient increases for constant temperature; with increasing temperature the coefficient decreases. The coefficient of rest is always lower than the coefficient of motion. The best material is asbestos which is compressed after weaving and ground even. It can stand temperatures up to 350°C and pressures of 2 kg per sq. cm; it has a friction coefficient of 0.3. Asbestos with wire stands the same temperature and has 0.2-0.3 for friction coefficient; but the pressure should be not more than 1 kg per sq. cm.—Ha.

Practical Experience in Hardness Testing. B. Brown. American Machinist, V. 73, Oct. 23, 1931, pages 651-654. Also discussion by C. H. Wilson, Wilson Maeulen Co., Inc., American Machinist, Vol. 73, Oct. 30, 1930, page 693.

The paper discusses the four types of hardness testing machines: (1) Indentation, such as standard Brinell, Brinell comparator, Pyramid, Rockwell, Alfred Herbert, and Hardometer. (2) Rebound machines, such as Scleroscope, and the Alpha Reboundimeter. (3) Ductility machines of the cupping variety, such as Erichsen, and the Erichsen-Olsen. (4) Others, including Herbert Pendulum, and the Cloudburst. The Brinell was the first really successful machine. Measurement of depth of indentation is usually more accurate than of the diameter of indentation. Cold weather gives increased oil viscosity and often causes wrong results. Time of application and ball size often lead to error. Etched balls make the microscope work more accurate. The Brinell comparator gives a rough estimate of hardness when used by an experienced man. It is of no value for thin sheet metal. The Rockwell machine uses a different scale from that of Brinell and this causes much confusion. Does not work well with material less than 0.04 in. thick unless very hard. The Pyramid tester appears to be the only indentation machine which may be used on very thin sheet. The Herbert machine is suited only for rough work and can not be used on hard metals. The Scleroscope is good for only flat surfaces and cannot be used on thin material. The Alpha Reboundimeter has about the same characteristics as the Scleroscope. Any imperfection on the surface is very likely to throw the ball sideways and cause error. Erichsen is valuable when much press work is done. It gives three sources of information: 1, depth of cup, 2, dome macrostructure, and 3, type of burst. Does not measure force required for drawing. The Erichsen-Olsen machine is similar to the last but also measures force for drawing up to 12,000 lbs. The Pendulum machine gives reliable results, readily convertible to Brinell scale. It also measures the potentialities of the metal for work hardening. The Cloudburst tests uniform hardness without damaging the surface. By reducing impacts so that the ball impression does not overlap the indentations may be measured and results converted to Brinell. Briefly gives principle and operation of each of the above mentioned machines. The discussion by C. H. Wilson admits the confusion due to difference in Rockwell and Brinell Scales. Discusses why the Rockwell machine could not use the Brinell scale, and indicates that in actual practice the Rockwell scale is as accurate as the Brinell. Also that it has a place in testing which cannot be taken by the Brinell tester.—R. H. P.

Weld Defects are Detected by Stethoscope Tests. Steel July 24, 1930, pages 46-47.

From Oxyacetylene Tips. Non-destructive tests of welds are made by striking the spot to be tested with a small hammer and noting the sounds given off by means of a stethoscope. Characteristic reedy tone of a defect is sufficiently different from that of a satisfactory spot so that the difference can be detected readily.—M. S.

Strip Steel for Razor Blades is Tested Magnetically. H. R. Simonds. Steel, Oct. 30, 1930, pages 51-53.

Auto Strop Safety Razor Co. has installed equipment for electromagnetic testing in its Newark, N. J., plant. Consists of 3 step-down transformers so arranged that any 2 may be electrically opposed and the current differential from the secondary winding measured on an oscillograph. The specimens to be tested are placed within the windings of the transformers to serve as cores. The differential oscillogram allows accurate comparison of one specimen with another and by using a known standard in one of the coils it is possible to ascertain accurately and without further examination such characteristics as microstructure, carbon segregation, defects, heat treating results, and carbon content. Transformers are mounted on a table about the size of an ordinary desk. There are slots in the center of each transformer for the insertion of the specimen, and suitable switches and instruments are mounted near the transformers. The oscillograph is in a separate room which is darkened. Normally, the oscillograph appears as a white line on a frosted glass surface.—M. S.

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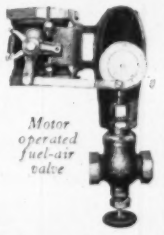

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Standard Shatter Test for Coke. Blast Furnace and Steel Plant, July 1930, pages 1157-1158.
Description of the apparatus and method adopted by the Midland Northern and Scottish Coke Research Committees.—M. S.

Modification of the Spinning-Film Hiding-Power Method. George S. Haslam (The New Jersey Zinc Co., Palmerton, Pa.) Industrial & Engineering Chemistry, Analytical Edition, July 15, 1930, pages 319-322.
Presented before the Division of Paint and Varnish Chemistry at the Atlanta Meeting of the American Chemical Society, April 1930. A technic has been developed for the measurement of the hiding power of a dry paint film. The test is essentially a refined paint-out test in which a uniform film is applied to a contrasty panel by spinning on an off-center spinning device. Dry hiding power does not check wet measurements, as made with the cryptometer, in every case and some of the exceptions are discussed.—M. E. H.

Testing Rubber under Compression. (Data supplied by) H. L. Scott & Co. The Rubber Age, January 25, 1931, pages 403-404.
Brief description of Scott Compression Tester and discussion of results obtained, together with compression characteristics of various materials and factors influencing results.—M. F. B.

Stress Analysis by Strain Gages. T. W. Greene. Product Engineering, January, 1931, pages 11-13.
Use of strain gages is described, and interpretation of resulting data for analyzing stress distributions in old and new designs set forth. Typical examples given.—M. F. B.

Elastic and Inelastic Behavior in Spring Materials. M. F. Sayre. Progress Report No. 7 of the A. S. M. E. Special Research Committee on Mechanical Springs (Technological). Presented at December, 1930, Annual Meeting.
Continuation of the fundamental studies begun in Progress Report No. 5 Trans. A. S. M. E., Vol. 52, No. 15, May-August, 1930, paper APM-52-9. The new results were obtained by the use of dead-weight loading instead of a testing machine as in the previous work. Other features were the use of long gage lengths and accurate control of temperature. The aim was a very high order of precision. Report (partial) gives numerous graphs and one summarized Table of moduli of elasticity. Among other results, it is shown that energy loss increases sharply with the stress, at a higher power than the square; that non-ferrous materials do not exhibit sharp rise in hysteresis on approaching yield point as in the case of heat-treated steels; that hysteresis loops are unsymmetrical and typically convex upward; and that in successive loops, starting from the same nominal initial load and rising to successively greater peak loads the ascending lines essentially coincide while the descending lines differ for the different loops.—M. F. B.

The Kelly Abrasion Machine. A. F. Hardman, W. L. MacKinnon and S. M. Jones. The Rubber Age. February 10, 1931, pages 463-465.
Description of a new machine so designed as to simulate wiping action in a portion of the tire tread under load. Comparisons made with other machines and actual road tests.—M. F. B.

Testing Earth Anchors. C. H. Klein. Bell Laboratories Record, February 1931, pages 274-277.
Since the Bell System adds to its plant several hundred thousand guy-rope anchors annually, their performance is of importance and a series of tests was recently conducted by the Outside Plant Department of the Laboratories at Asbury Park, with 100 anchors of various types. The paper describes the test procedures and the special dynamometer, with means of applying loads up to 50,000 lbs.—M. F. B.

Photoelasticity and Its Application in Design. R. V. Baud. Machine Design, November, 1930, pages 29-32, December, 1930, pages 27-30, January, 1931, pages 37-40, 52.
The first article discusses the choice of methods enabling the designer to judge the safe load of a structure when no service records exist: one is to combine all factors involved in a destruction test; the other to secure stress field information. This second again divides itself into the method of analytical computation of stresses, and the more practical way of making photoelastic tests. The principles are explained, the instruments described, definitions given, and eight well-selected illustrations contribute to the exposition. The second article covers work done at the mechanics division of the Westinghouse Electric & Mfg. Co.'s research laboratories on gears, bolts, suspension insulators, glassware, and locomotive side frames. 10 figs. The third article similarly treats rails; welds; fastenings: (a) turbine blades, (b) salient poles, (c) airplane propellers; turbo-elements: (a) coil retaining wedges, (b) teeth and end-plates; commutators. 13 figs.—M. F. B.

Obviating Mechanical Troubles by Balancing of Parts. Werner I. Senger. Machine Design. January, 1931, pages 29-32.
Balancing provides means for eliminating many mechanical difficulties such as excessive bearing wear or failure, breakage of parts, excessive power loss, increase in amount of lubricant, improper functioning, etc. Examples are given. Balancing also effects reduction in machining, of which examples are also given. Types of vibration which balancing machines cannot eliminate are given. Static and dynamic unbalance is explained. Static and dynamic balancing machines are described, together with their operation.—M. F. B.

The Measurement of Permeability of Porous Alundum Discs for Water and Oils. Holbrook G. Botset. The Review of Scientific Instruments, February, 1931, pages 84-95.
Description of apparatus and reports of experiments conducted at the Gulf Research Laboratory, Pittsburgh, to gain a more accurate knowledge of the flow of liquids in underground reservoirs. Before making experiments with complex hydrocarbons such as a crude oil, experiments with water flow through alundum discs were conducted and gave surprising results. First experiments showed slowing down of rate of flow, but when water was prefiltered through a fresh alundum disc before making the run in the permeability apparatus, the cause which slowed up the filtration rate was entirely removed. Then, the prefiltered and de-gassed water was let stand two days in a glass vessel with no air space above the water, and the filtration rate again showed a slowing down, presumably from the hydrolysis of the glass by distilled water, as indicated by subsequent runs. Formation of colloidal silica probably also clogs the fine pores. Further experiments were made with kerosene, light lubricating oil and crude oil, the rate of flow also decreasing with time, which decrease here appeared to be due to the presence of unsaturated hydrocarbons in the liquids: these upon oxidation form complex substances often gummy. In the presence of illuminating gas, the rate of flow of a crude was shown to be practically constant. Therefore, all laboratory experiments, to give results representative of conditions in an oil sand, must always be made in an atmosphere containing no oxygen—preferably in the presence of a methane atmosphere.—M. F. B.

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Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Determination of Mechanical Properties of Steel. R. L. Temp'in. Proceedings of Engineers' Society of Western Pennsylvania, Vol. 46, December, 1930, pages 313-321; discussion 321-326.

Relationship between mechanical properties are first discussed, and then the methods for determining the properties, under which standardization is emphasized, as well as the recognition of the statistical element. Under testing machines and apparatus, the author deplores the fact that there are instruments which so far appear to be capable of merely testing a specimen without giving results of generally recognized significance of usefulness, and he gives numerous bits of advice in connection with selection, installation and operation. The discussions centered about the relationships between properties.—M. F. B.

Critical Study of the Bursting Strength Test for Paper. F. T. Carson and F. V. Worthington. Bureau of Standards Journal of Research, Vol. 6, No. 2 (1931). Page 339.

An extensive investigation has been made of alleged variables in the bursting test. The study included clamping pressure, nature of clamping surfaces, size of bursting orifice, types of diaphragms effect of manner of installation of diaphragms, effect of air entrapped under diaphragm, speed of operation, effect of viscosity of liquid medium in hydraulic chamber, calibration and performance of pressure gages, relation of bursting to tensile results, and relation of size of bursting orifice to bursting pressure. A device is described for measuring the vertical deflection of the paper in the bursting test.

The Tensile Properties of Alloy Steels at Elevated Temperatures as Determined by the "Short-Time" Method. William Kahlbaum, R. L. Dowdell, and W. A. Tucker. Bureau of Standards Journal of Research, Vol. 6, No. 2 (1931). Page 199.

By means of "short-time" tension tests a series of alloy steels has been tested at different elevated temperatures. The proportional limit was determined in each case. The materials tested were a plain carbon steel and commerical alloys of chromium, vanadium, and iron with and without additions of tungsten, silicon, or aluminum; also chromium-tungsten, nickel-molybdenum and several austenitic steels with and without tungsten. Metallographic study revealed very little intercrystalline weakness and no marked or singificant change in structure resulting from the high temperature tests. The addition of tungsten increases the "structural stability" of the austenitic alloys. Hardness was determined as a further indication of tempering which might have occured during the heating. A comparison of "short-time" test and "flow test" for pearlitic and austenitic steel is included.

Compressive Tests of Jointed H-Section Steel Columns. James H. Edwards, H. L. Whittemore, and A. H. Stang. Bureau of Standards Journal of Research, Vol. 6, No. 2, (1931), page 305.

Jointed steel columns consisting of various combinations of 10-inch, 12-inch, and 14-inch rolled steel H-sections, were tested in compression. Some of the tests were made with the axes of the columns in line and the others with the outer faces of both upper and lower columns in the same plane. Each combination of H-sections and column arrangement was tested with five bearing plates ranging in thickness from 1 inch to 4½ inches using "low loads" giving an average stress not exceeding 8,500 lbs./in.^{2} in the smaller (upper) column. Tests to failure and repeated-load tests were made on a few specimens. Strain-gage readings were taken on 2-inch gage lines on the columns and on 8-inch gage lines on the plates. The deflection of the bearing plates was measured.

Strain Measurement in the Reinforcement for the Dome of the Natural History Building. W. C. Lyon, H. L. Whittemore, A. H. Stang, and L. R. Sweetman. Bureau of Standards Journal of Research, Vol. 6, No. 2, (1931), page 183.

Slight outward movement of the brick piers supporting the dome over the rotunda of the Natural History Building of the National Museum caused cracks along the joints in the masonry and in the stone arches under them. To reinforce the structure pendentives were surrounded by a framework of structural steel. Inwardly directed forces were exerted on the masonry by many screw jacks, to prevent further movement. To control the jacking operation, readings were taken on a large number of gage lines on the frame work, using a Whittemore strain gage. The stress in the framework was computed from these readings. Approximately the desired stress in each member was obtained. The safety of the dome and its supporting structure was assured.

A Portable Instrument for Measuring Air Permeability of Fabrics. H. F. Schiefer and A. S. Best. Bureau of Standards Journal of Research, Vol. 6, No. 1 (1931), page 51.

A self-contained instrument for measuring the flow of air through fabrics is described. The specimen to be tested is clamped between two orifice rings under a slight tension. Air is drawn through the fabric and through a calibrated orifice meter by a suction fan. The pressure drop across the fabric and across the orifice meter are measured, respectively, by inclined and vertical water gages. The volume of air passing through the fabric at a given pressure drop is thus obtained. With a set of nine orifices ranging in diameter from 1 to 16 mm the flow of air may be measured for a wide variety of fabrics, ranging from closely woven to loosely knit constructions. Three typical air permeability curves are shown. Typical data for two speciments taken from different portions of the same silk cloth are given and discussed. It is shown that the variation in air permeability because of the nonuniformities in the cloth is greater than the experimental uncertainty.

TIME, SPEED & ACCELERATION

Measurements of Temperature Coefficient and Pressure Coefficient of Quartz Crystal Oscillators. S. Leroy Brown and Sidon Harris. The Review of Scientific Instruments, March 1931, pages 180-183.

A method of measurement is used whereby variation in frequency of a high frequency oscillator can be measured easily to a fraction of a part in a million. The audible difference in tone produced by a harmonic of a constant, high frequency oscillator and a harmonic of a second oscillator is compared to the tone of a variable, calibrated audio frequency oscillator. Any change of the frequency of the second high frequency oscillator is measured to a fraction of a cycle per second. This method of measurement is used to determine the effects of temperature and pressure on the frequency of a piezo-electric oscillator. The temperature effect is of the order of 20 parts per million per degree C, while the pressure effect is of the order of only 6 parts per million per atmosphere.

The Cathode Oscillograph as Precision Measuring Instrument. (Der Kathoden-oszillograph als Praezisionmessgeraet). H. Viehmann. Eleckt. Zech. Vol. 52. No. 7, Feb. 12, 1931, page 212. Archiv Elektrotechnik Vol. 24, No. 3, Page 369.

Comparison of numerous oscillograms showed an average accuracy of 1%, average error 0.45 to 0.66%, max. error 1.3%.—Ha.

The New Siemens Universal Oscillograph. (Der neue Siemens-Universal oszillograph). Fr. Eichler and W. Garz. Siemens Zeitschrift, Vol. 10, No. 11, Nov. 1930, pages 598-604. No. 12, Dec. 1930, pages 635-644.

Detailed description. The instrument is built with up to six measuring loops for recording and at the same time making visible simultaneously six AC periodical or transient phemonina, f.i., the

Humidity & Temperature
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Illinois Testing Labs., Inc.
Leeds & Northrup Co.
Minneapolis Honeywell Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Liquid Level
Automatic Temp. Control Co.
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Illinois Testing Labs., Inc.
Meriam Co.
Tagliabue Mfg. Co., C. J.

ressure & Vacuum
Automatic Temp. Control Co.
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Meriam Co.
Minneapolis-Honeywell Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Pyrometer
Bristol Company
Brown Instrument Co.
Claud S. Gordon Co.
Illinois Testing Labs., Inc.
Leeds & Northrup Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Rate-Volume
Foxboro Co.

Refrigeration
Automatic Temp. Control Co.
Bristol Co.
Brown Instrument Co.
Leeds & Northrup Co.
Taylor Instrument Cos.
Westinghouse Elec. & Mfg. Co.

Special
Automatic Temp. Control Co.
Leeds & Northrup Co.
Minneapolis-Honeywell Co.
Rubicon Company

Tachometer
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Weston Elec. Inst. Corp.

Temperature-Time
Automatic Temp. Control Co.
Bristol Co.
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Illinois Testing Labs., Inc.
Leeds & Northrup Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.

Thermometer
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Illinois Testing Labs., Inc.
Leeds & Northrup Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Thermostat
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Minneapolis-Honeywell Co.
Taylor Instrument Companies
Westinghouse Elec. & Mfg. Co.

Thickness
Esterline-Angus Company

Time
Automatic Temp. Control Co.
Bristol Co.
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Illinois Testing Labs., Inc.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.

Unit Heater
Minneapolis-Honeywell Co.

Vacuum
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Meriam Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.

Valve—Motor Operated
Automatic Temp. Control Co.
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Minneapolis-Honeywell Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Water Level
Bristol Company
Brown Instrument Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.

CONVERTERS
Bodine Electric Co.

COORINATOGRAPHS

COUNTERS—Revolution
Amthor Testing Inst. Co.
Bristol Company
Brown Instrument Co.
Southwark Fdry. & Mach. Co.

Stroke
Bristol Company
Southwark Fdry. & Mach. Co.

COUPLING TRANSFORMERS
General Radio Company

CURRENT RECORDERS
Bristol Company
Leeds & Northrup Co.

CURRENT REGULATORS
Westinghouse Elec. & Mfg. Co.

CYCLE COUNTERS
General Radio Co.

CYLINDERS-GRADUATED
Tagliabue Mfg. Co., C. J.

DECELEROMETER

DEFORMETER (Beggs)
Southwark Fdy. & Mach. Co.

DEMAND METERS

Gas
Foxboro Company

Electric
Westinghouse Elec. & Mfg. Co.

DENSITOMETERS

DENSOMETERS

DIVIDING HEAD

Optical
Bausch & Lomb Optical Co.

DIVIDING MACHINES
R. Y. Ferner Co.
Gaertner Scientific Corp.

DRAFT GAGES—see Gages

DYNAMIC BALANCING EQUIPMENT
Alfred Suter

DYNAMOTORS
Bodine Electric Co.

EARTH CURRENT METERS
Rawson Elec. Inst. Co.

ELECTRIC TELEMETER
Southwark Fdry. & Mach. Co.

ELECTRIC WAVE FILTER SECTIONS
General Radio Company

ELECTROMETERS
Rubicon Co.

EMPLOYEES' "IN AND OUT" TIME RECORDERS

ENGINE INDICATORS
Southwark Fdry. & Mach. Co.

EXTENSOMETER
Southwark Fdry. & Mach. Co.
Alfred Suter

FADE-OMETER
Atlas Electric Devices Co.

FATIGUE TESTERS
Atlas Electric Devices Co.
Southwark Fdry. & Mach. Co.
Alfred Suter

FAULT FINDERS
General Radio Co.
Leeds & Northrup Co.
Rubicon Company
Weston Electrical Inst. Corp.

FLASH & BURNING POINT TESTERS
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.

FLOW METERS
Brown Instrument Co.
Foxboro Co.
Meriam Co.

FLUXMETERS
Leeds & Northrup Co.
Rawson Electrical Instr. Co.

FOLDING TESTER

FRACTIONAL HORSEPOWER MOTORS
Bodine Electric Co.

FREEZING CABINET
Atlas Electric Devices Co.

FREQUENCY METERS

Indicating
Jewell Electric Instrument Co.
Leeds & Northrup Co.
Westinghouse Elec. & Mfg. Co.
Weston Elec. Inst. Corp.

Controlling
Leeds & Northrup Co.

Recording
Bristol Company
Leeds & Northrup Co.

Standards
General Radio Co.

FUEL ANALYSIS APPARATUS
Burgess-Parr Co.

FUEL FLOW INDICATOR

FURNACE CONTROLS
Automatic Temp. Control Co.
Leeds & Northrup Co.
Taylor Instrument Cos.

FUSES
Instrument
Littlefuse Laboratories

GAGE RODS
Tagliabue Mfg. Co., C. J.

GAGE TESTING OUTFITS
Amthor Testing Inst. Co.

GAGES

Absolute Pressure
Bristol Company
Brown Instrument Co.
Foxboro Co.
Meriam Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Amplifying
B. C. Ames Co.
Federal Products Corp.
R. Y. Ferner Co.

three voltages and three currents in a three-phase system. The sensitivity can be arranged from 1.2 ampere per mm deflection on the photographic paper to 0.075 ampere, the system frequency can be selected from 2000 to 10,000 per second. The whole arrangement is made easily portable.—Ha. & G. N.

Six-Gear Portable Tachometer. Electrical Review, Nov. 21, 1930, page 886.

Hand tachometer recently introduced by Geo. Thomas & Co., Ltd., Manchester, England, is operated on the pendulum or fly-weights principle, and is equipped with a six-speed gear box. A total speed range from 25-30000 r.p.m. is covered.—M.S.

Micromotion Explained. R. M. Blakelock. Industrial Record, April 1931, pages 32, 68, 71.

Micromotion is a method of job analysis employing motion picture of job in question, having clock-timing device in view when picture is taken; the clock having a hand revolving 20 R.P.M. and a face divided into 100 divisions. As film records all motions made by operator, together with position of hand of clock by stopping the film and projecting each frame by hand, any or all motions may be observed, together with time required to within 1/2000 minute. It has been possible to arrive at basic laws which govern best motion practice. These fundamentals, when thoroughly understood, may be applied without the use of motion picture and, when practiced, have a decided effect upon the skill of an operator.—M.F.B.

Engine Acceleration. Clarence S. Bruce. Motive Power, February, 1931, pages 25-28, 47-48.

This study presents comparisons of fuel performance with downdraft and updraft induction systems and with 3 separate carburetors connected by short pipes to the 3 intake ports of the test engine. Although latter arrangement roughly represents cold carburetion, complete parallelism with the other series of tests is not possible since the 3 carburetors were not equipped with accelerating-charge pumps. The author stated that the character of the interior surface of the manifolds had a marked effect on acceleration. 9 diagrams, 3 photographs, 13 references.—M.F.B.

ELECTRICITY & MAGNETISM

Present Status of Remote Measuring Practice. (Der heutige Stand der Fernmesstechnik.) Elektrotechnik und Maschinenbau, Aug. 17, 1930, pages 773-774.

Includes bibliography. Review of the various systems in use.—M.S.

Electrical Methods of Weighing Atoms. (Les méthodes électriques de pesée des atomes). L. Bruninghaus. Revue Générale de l'Electricité, Aug. 9, 1930, pages 195-203.

Outline of the principles of the method and some of the principal results obtained.—M.S.

Improvement of Cable System by Conductor Temperature Compensated by Pfannkuch-Rottsieper Efficienty Method. (Erhöhung des Wirkungsgrades von Kabelneutzen durch Leitertemperatur-Ueberwachung nach System Pfannkuch-Rottsieper) K. Rottsieper A.E.G. Mitteilungen March, 1931, pages 152-158.

It is shown that the economy of cable systems can be improved by taking exactly into account the ground temperature by observing continuously the cable temperature. An arrangement is described in detail which permits at any time to determine the temperature of the cables during service. The method, also described in detail, is based on a continuous measurement of the resistance of a test loop built into the conductor by means of a wattmetric instrument in bridge connection.—Ha.

New Application of Remote Measuring Arrangements. (Neue Auwendung von Fernmesseinvichtungen). Walter Stern. Elekt. Zschr. Vol. 52, No. 9, Feb. 26, 1931, page 268-269.

Simplified remote control and measuring arrangements make it often useful and advantageous to use this method even for cases where direct measurements could be employed. This can occur in power stations for instance for the summation in tele-watt instruments, etc. A few examples and diagrams are given.—Ha.

Testing of Electrical Hot-plates by the Evaporation Method. (Die Nachprufung elektrischer Kochplatten nach der Verdampfungsmethode). F. Opacki. Elekt. Zsch. Vol. 52, No. 11, March 12, 1931, page 355. Elektrot & Maschimenban Vol. 48, page 614.

A method for the determination of the efficiency of hot-plates is developed which is independent of the differences due to the vessel in which a liquid is brought to boil. A certain amount of water is evaporated; after the first evaporation (from cold state) the same amount of water is again filled in and this repeated 9 times. Every time, evaporation time and consumption are exactly measured. The efficiency of the transmission is then easily determined from the consumed energy and the work of evaporation.—Ha.

Regulation of Current for Laboratory Measurements. (Stromregelunigen bei Laboratoriumsmessungen). F. Hauffe. Elekt. Zsch. Vol. 52, No. 11, March 12, 1931, pages 340-341.

To obtain fine regulation, a coarse and a finer resistance are often connected in parallel. The range of such a combination and its calculation are derived and illustrated by an example. By means of the formula it is easy to calculate a proper set of resistances for any desired range—Ha.

Simplified Tests of Installations and Meters in Stationary Electrical Plants. (Vereinfachung von Installations-und Zähler prüfungen bei ortsfesten elektrischen Auschlussanlagen). A.E.G.-Mitteilungen, March 1931, pages 138-139.

A new method which permits a test of meters without removal of cover by means of special test terminal.—Ha.

New Differential Relay. (Neues Differentialrelais) G. Stark. A.E.G. Meteilungen, March 1931, pages 148-152.

This differential protective relay eliminates false alarms due to assymmetries in the current transformers by making the latter inoperative, which is achieved by adding to the constant counter-torque another variable counter-torque proportional to the primary current.—H.A.

The Measurement of High Voltages with the Schering-Bridge. (Uber die Messung hoher Spannungen in der Brücke nach Schering). H. Tenss, El. Zsch., Vol. 52, No. 1, Jan. 1, 1941, pages 7-8.

When measuring dielectric losses or the dielectric constant of insulating material with the Schering bridge which gives the best results the voltage applied has to be measured separately by potential transformers or otherwise—which means very costly apparatus. The author describes a modification which connects in that branch of the bridge containing the standard condenser, a precision condenser in series with the former and divides in this way the high-tension capacitatively. The formulas for the calculation of the total voltage from the partial voltages are developed; the whole arrangement is described.—Ha.

The Shaping of Testing-Electrodes According to Rogowski. (Die Ausbildung von Prüfelektroden nach Rogowski). Carl Stoerk. El. Zsch. Vol. 52, No. 2, Jan. 8, 1931, pages 43-45.

When making tests or experimenting with high-tension it is most advantageous to have an electric field as uniformly as possible leading over into the surrounding field. The limitation of electrodes permit only an approach to this condition, but with a shape as suggested by Rogowski a very

Comparator
B. C. Ames Co.
Federal Products Corp.
R. Y. Ferner Co.

Cylinder
B. C. Ames Co.
Federal Products Corp.
R. Y. Ferner Co.

Deformation
Southwark Fdry. & Mach. Co.

Depth
B. C. Ames Co.
Brown Instrument Co.
Federal Products Co.
Foxboro Company

Dial
B. C. Ames Co.
Federal Products Corp.
R. Y. Ferner Co.

Differential Pressure
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Meriam Co.
Tagliabue Mfg. Co., C. J.

Draft
Amthor Testing Inst. Co.
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Meriam Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Drill
Bausch & Lomb Optical Co

Grinding
Federal Products Corp.

Liquid Level
Bristol Company
Brown Instrument Co.
Foxboro Co.
Illinois Testing Labs., Inc.
Meriam Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Loss of Head
Bristol Co.
Brown Instrument Co.
Foxboro Co.
Meriam Co.

Pitch Diameter
Federal Products Corp.
R. Y. Ferner Co.

Pocket
Amthor Testing Inst. Co.
Federal Products Corp.

Pressure
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Leeds & Northrup Co.
Meriam Co.
Alfred Suter
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Pressure-Temperature
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Illinois Testing Labs., Inc.
Leeds & Northrup Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.

Pressure & Vacuum
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Meriam Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Profile
Bausch & Lomb Optical Co.

Rain
Taylor Instrument Companies

Recording—Distance
Bristol Company
Brown Instrument Co.
Claud S. Gordon Co.
Taylor Instrument Cos.

Strain
Southwark Fdry. & Mach. Co.
Alfred Suter

Tester
Southwark Fdry. & Mach. Co.

Thickness
B. C. Ames Co.
Amthor Testing Inst. Co.
Federal Products Corp.
R. Y. Ferner Co.

Volume
Brown Instrument Co.
Foxboro Co.
Meriam Co.

Water Level for Boilers
Bristol Company
Brown Instrument Co.
Foxboro Co.

Wind
Bristol Co.
Brown Instrument Co.
Taylor Instrument Companies

GALVANOMETERS
Brown Instrument Co.
General Radio Co.
Claud S. Gordon Co.
Illinois Testing Labs., Inc.
Jewell Electrical Instrument Co.
Leeds & Northrup Co.
Rawson Elec. Inst. Co.
Rubicon Company
Westinghouse Elec. & Mfg. Co.
Weston Electrical Inst. Corp.

GAS ANALYTICAL METERS
Chemical
Tagliabue Mfg. Co., C. J.

Electrical
Brown Instrument Co.
Leeds & Northrup Co.

GAS LEAK INDICATORS
Taylor Instrument Companies

GASOLINE METERS
Buffalo Meter Co.

GAS-METERS
Brown Instrument Co.
Foxboro Co.
Meriam Co.

GASOMETERS

GEOPHYSICAL INSTRUMENTS

GOVERNORS
Laboratory Dry & Wet Gas

Pressure
Bristol Company
Brown Instrument Co.
Tagliabue Mfg. Co., C. J.

Pump
Tagliabue Mfg. Co., C. J.

GLASS STRAIN TESTERS

GREASE TESTING APPARATUS
Tagliabue Mfg. Co., C. J.

GROUND DETECTORS
Leeds & Northrup Co.
Rubicon Company
Westinghouse Elec. & Mfg. Co.
Weston Electrical Inst. Corp.

GROUND-OHMER
Leeds & Northrup Co.

GYPSUM TESTING INSTRUMENTS
Alfred Suter

HARDNESS TESTERS
Claud S. Gordon Co.
Southwark Fdry. & Mach. Co.
Alfred Suter

HARMONIC ANALYZERS
Leeds & Northrup Co.

HELIOSTATS
Gaertner Scientific Corp.

HIGH FREQUENCY APPARATUS
Rubicon Company
Weston Elec. Inst. Corp.

HIGH VOLTAGE

Fuses
Littelfuse Laboratories

Indicators
Weston Elec. Inst. Corp.

Measuring Devices
Westinghouse Elec. & Mfg. Co.
Weston Elec. Inst. Corp.

Testing Devices
Westinghouse Elec. & Mfg. Co.

HUMIDITY CONTROLLERS
Bristol Company
Foxboro Co.
Taylor Instrument Cos.

HUMIDITY RECORDERS
Wet & Dry Bulb Thermometers
Bristol Company
Brown Instrument Co.
Foxboro Co.
Leeds & Northrup Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

HYDROGEN ION METERS
Indicating
Leeds & Northrup Co.
Rubicon Company

Controlling, Recording
Leeds & Northrup Co.

HYDROMETERS
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

HYGROMETERS
Brown Instrument Co.
Foxboro Co.
Leeds & Northrup Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

IMPACT HARDNESS TESTER
Alfred Suter

IMPACT TESTING MACHINES
Alfred Suter

Alternating

INDICATORS See Gages

INDUCTANCES
General Radio Co.
Leeds & Northrup Co.
Rubicon Company

INSTRUMENT CALIBRATION AND REPAIRS
Amthor Testing Inst. Co.
Claud S. Gordon Co.
Jewell Electrical Instrument Co.
Rubicon Company
Weston Elec. Inst. Corp.

INSTRUMENT FUSES
Littlefuse Laboratories

INSTRUMENT OILS
William F. Nye, Inc.

INSTRUMENT TRANSFORMERS
Jewell Electrical Instrument Co.
Westinghouse Elec. & Mfg. Co.
Weston Electrical Inst. Corp.

uniform field can be produced by shaping a marginal bulge of the electrodes according to equipotential lines. The author develops a method for the graphical determination of the shape of the bulge. A numerical example illustrates the method; seven references are cited.—Ha.

The Question of Minimum Capacity of Instrument Transformers (Zur Frage der Mindestleistung der Messwandler). George Keinath. E.T.Z., Vol. 51, No. 51, Dec. 18, 1930, pages 1738-1739.

The author proposes, for the sake of increasing the thermal and dynamic strength of current transformers, to reduce the present minimum capacity of 15 VA in special cases to 5 VA by simultaneously reducing the secondary current from 5 A to 1 A. By this means it would become possible in cases where exceeding high short-circuit currents can occur to use the rod-shaped transformers which have proved to be absolutely short-proof, to a much greater extent. A similar suggestion is made for potential transformers. At present, transformers of this kind have been almost universally standardized for a secondary current of 5 A or 100 volts.—Ha.

A Method for Measuring Wire Losses at High Frequencies. (Eine Methode zur Messung von Eisenverlusten bei Hochfrequenz). Peter Glebow. Elektrot. Zech. Vol. 52, No. 7, Feb. 12 1931, pages 205-209.

Method, mentioned 18 years ago by Schmidt, is very suitable for measuring high-frequency losses in iron. An ammeter is used and the total current of the circuit is measured. Then it is assumed that the magnetizing current depends only on the induction and not on the frequency, which the author shows to be practically correct. If, therefore, the current is measured at any frequency, f.i. the frequency of the system (50) but at the same induction as in the high-frequency circuit, the magnetizing current is easily obtained. The iron losses are the product of volt current in phase with the voltage and the magnetizing current can now be determined from $\sqrt{I_t^2 + I_m^2}$ where I_t is the total current and I_m the magnetizing current as before described. Several tests with frequencies up to 7700 show that this method is almost more exact than the calorimetric method now mostly used for these measurements, but above all it is much simpler.—Ha.

Simplified Tilting Relay for Synchronous Time-flection of a Braun's Tube with Glow Cathode. (Vereinfachtes Kipprelais für synchrone Zeitablenkung einer Braunschen Röhre mit Glühkathode). J. Kammerloher Elekt. Zsch., Vol. 52, No. 3, Jan. 15, 1931, page 78-79.

For the reproduction of periodical alternating current phenomena an arrangement is described which gives an absolute proportionate time deflection and is synchronous with the alternating voltage to be investigated. The simpler arrangement is entirely sufficient for the frequencies below 5000. 11 references.—Ha.

Obtaining Measuring Voltages Off Very High Operating Voltages (Gewinnung von Messpannungen bei sehr hohen Betriebsspannungen). B. Kalkner. Forschung und Fechnik 1930, pages 304-312.

With the coming of very high tension lines the question of acurate methods of measuring voltages has become acute. The author first reviews the usual methods with their inherent advantages and drawbacks and then describes the more recent methods of which three distinct ones have been developed: (1) the single-part transformer, (2) subdivision of the high-tension, the cascade tranformation, (3) measuring with series resistance, especially series condensers. The various contructions under (1) are described. Especially promising seems to be the dry transformer of F. J. Fischer which is built up in such way that no great voltage differences occur in any part of the transformer. This type is suitable for voltages up to 60 KV, and a number can easily be arranged in series for high voltages. For cascade transformers a few winding arrangements are described for the special purpose of reducing inaccuracies and proper coupling of fluxes. Condensers have found favor on account of their greater capacity and less dependence on exterior influences, often also their lower price. The recent developments have exerted a certain influence on the whole layout of switching stations as the lower prices and space requirements permit of applications for safety arrangements which formerly had been often omitted.—Ha.

Reactive KVA Metering. E. C. Goodale. Electrical West, Aug. 1, 1930, pages 54-67; Sept. 1, 1930, pages 140-141; Nov. 1, 1930, page 232; Dec. 1, 1930, pages 286-288.

Discusses some fundamentals and deals with methods of measuring reactive kva. in a single-phase circuit, two-phase three-wire and four-wire reactive metering, and three-phase three-wire reactive metering using phase-shifting auto-transformers.—M. S.

Methods and Simple Apparatus for the Study of the Resistivity of Insulating Oil (Methodeset appareils simples pour l'étude de la résistivité des hiles isolantes). Masson, L'Industrie Électrique, Aug. 10, 1930, pages 344-345.

Describes experiments carried out with a small portable apparatus supplied with a Wimshurst machine. The direct-current dielectric strength and the relation of resistivity to temperature may be measured by this means.—M. S.

Methods of Testing Insulators (Méthodes d'essai des isolants). Grosselin. L'Industrie Électrique Sept. 10, 1930, pages 397-402.

From a paper presented to the Conférence des Grands Réseaux, 1929. Describes the use of insulators, and discusses methods of testing, considering those in use in Germany, United States, and France.—M. S.

Three-Phase Metering. Oliver Howarth. Electrical Review, Dec. 5, 1930, page 970.

Extracts from a paper read before the Meter and Instrument Section of the Institution of Electrical Engineers. Discusses some of the inaccuracies introduced by auxiliary apparatus and special fitments. Most accurate method of metering a low-voltage 3-phase supply when the neutral point is available is by means of three single-phase meters. A 3-phase meter is essential for measuring maximum demand. For 3-wire supply without the neutral point, a 3-phase, 3-wire meter is more satisfactory than two single-phase meters. In general, the single-phase meter is inherently more accurate than the 3-phase meter.—M. S.

Alternating Wave Forms. D. W. D. Barham and S. R. Brewer. Electrical Review, Oct. 24, 1930, pages 680-681.

Describes the use of the valve voltmeter for their delineation.—M. S.

High-Voltage Measurement. J. Plummer. Electrical Review, Nov. 28, 1930, pages 902-903.

Discusses the principles underlying accurate determination of electrical pressures and considers various methods of measurement. Simplest and most useful method of measuring high voltages is to use an electrostatic voltmeter of the Ayrton and Mather type in conjunction with a condenser bushing. The bushing consists of a central conductor (forming the high-pressure terminal) encircled by a number of concentric insulating tubes arranged with metallic intersheaths to control the distribution of the potential gradient from the inner conductor to earth.—M. S.

Determining the Throwing Power of Chromium Plating Baths With the Cavity Scale. L. C. Pan. Metal Cleaning and Finishing, Sept. 1930, pages 753-756, Oct. 1930, pages 851-854, 876.

Defines throwing power and outlines early methods of measuring it. Author has developed the cavity scale, an instrument consisting of a metal bar with holes of graded depths. These cavities

INSULATION TESTING EQUIPMENT
Leeds & Northrup Co.
Rubicon Company
Westinghouse Elec. & Mfg. Co.

INTEGRAPHS & INTEGRATORS
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INTERFEROMETERS
Gaertner Scientific Corp.

INVERTED CONVERTERS
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JOB TIMING RECORDERS

KEYS AND SWITCHES
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Rubicon Company

KILNBOY
Foxboro Co.

KILOVOLT AMPERE METERS

KLYDONOGRAPHS
Westinghouse Elec. & Mfg. Co.

LABORATORY WASHING MACHINES
Atlas Electric Devices Co.

LACTOMETERS
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.

LAUNDER-OMETER
Atlas Electric Devices Co.

LENGTH MEASURING MACHINES
R. Y. Ferner Co.
Gaertner Scientific Corp.

LEVELS
Centering
Bausch & Lomb Optical Co.
R. Y. Ferner Co.
Engineer's, Wye, Precision, Prism
R. Y. Ferner Co.
Taylor Instrument Companies

LIQUID METERS
Buffalo Meter Co.

LOCOMOTIVE INDICATORS
Southwark Fdry. & Mach. Co.

LUSTER METERS

MACHINE OILS
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Rubicon Company

MANOMETERS
Brown Instrument Co.
Foxboro Co.
Meriam Co.
Alfred Suter

MASTER CLOCKS
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MEGOHMMETERS
Illinois Testing Labs., Inc.
Leeds & Northrup Co.
Rubicon Company

MEGOHM VOLTMETERS
Jewell Electrical Instrument Co.
Weston Electrical Inst. Corp.

MELTINGPOINT APPARATUS
Claud S. Gordon Co.
Tagliabue Mfg. Co., C. J.

METER PROVERS, Gas

METER TESTERS, Gas

MICROMETERS
Amthor Testing Inst. Co.
R. Y. Ferner Co.
Gaertner Scientific Corp.

MICROAMMETERS
Jewell Electrical Instrument Co.
Rawson Electrical Instrument Co.
Weston Electrical Inst. Corp.

MICROFARADMETERS
General Radio Co.
Jewell Electrical Instrument Co.
Leeds & Northrup Co.
Rubicon Company
Weston Electrical Inst. Corp.

MICRO PYROMETERS

MICROSCOPES
Brinell
Bausch & Lomb Optical Co.
Gaertner Scientific Corp.
Claud S. Gordon Co.
Spencer Lens Co.
Alfred Suter
Measuring
R. Y. Ferner Co.
Metallographic
Bausch & Lomb Optical Co.
Claud S. Gordon Co.
Spencer Lens Co.
Petrographical
Bausch & Lomb Optical Co.
Spencer Lens Co.
Toolmakers'
Bausch & Lomb Optical Co.
Gaertner Scientific Corp.
Spencer Lens Co.

MICROTOMES
Bausch & Lomb Optical Co.
Spencer Lens Co.

MILLIAMMETERS
General Radio Co.
Jewell Electrical Instrument Co.
Rawson Electrical Instrument Co.
Weston Electrical Inst. Corp.

MILLIVOLTMETERS
Bristol Company
Brown Instrument Co.
Illinois Testing Labs., Inc.
Jewell Electrical Instrument Co.
Rawson Electrical Instrument Co.
Taylor Instrument Companies
Weston Electrical Inst. Corp.

MOTOR RADIATOR VALVES
Minneapolis-Honeywell Co.

MOTION RECORDERS
Mechanical
Bristol Company
Foxboro Co.
Southwark Fdry. & Mach. Co.

MOTORS
Bodine Electric Co.

MOTOR GENERATOR SETS
Bodine Electric Co.

MULTIMETERS
Rawson Electrical Instrument Co.

MULTIPLIERS
Jewell Electrical Instrument Co.
Leeds & Northrup Co.
Weston Electrical Inst. Corp.

NEON FILLED TUBES

NEPHELOMETERS
Spencer Lens Co.

OHM METERS
General Radio Co.
Jewell Electrical Instrument Co.
Leeds & Northrup Co.
Rawson Electrical Instrument Co.
Rubicon Company
Weston Electrical Inst. Corp.

OILS
William F. Nye, Inc.

OIL METERS
Buffalo Meter Co.
Claud S. Gordon Co.

OIL TESTING APPARATUS
Atlas Electric Devices Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

OPERATION RECORDERS
Electrical
Bristol Company
Brown Instrument Co.
Foxboro Co.
Leeds & Northrup Co.
Tagliabue Mfg. Co., C. J.

ORIFICE METERS
Brown Instrument Co.
Foxboro Co.
Meriam Co.

ORSAT APPARATUS

OSCILLOGRAPHS
General Radio Co.
Westinghouse Elec. & Mfg. Co.

OXYGEN RECORDERS
Leeds & Northrup Co.
Tagliabue Mfg. Co., C. J.

PAINT TESTING INSTRUMENTS
Atlas Electric Devices Co.

PANTOGRAPHS
Gaertner Scientific Corp.

PAPER TESTING INSTRUMENTS
Atlas Electric Devices Co.

PERFORMANCE METER

PERMEAMETERS
Leeds & Northrup Co.
Rubicon Company

PAPERTESTINGINSTRUMENTS
Amthor Testing Inst. Co.
Spencer Lens Co.

PERISCOPES
Bausch & Lomb Optical Co.
Gaertner Scientific Corp.

PHASE INDICATOR
Westinghouse Elec. & Mfg. Co.

PHASE SEQUENCE INDICATOR

PHONOGRAPH TURNTABLES, Electric
Bodine Electric Co.

PHOTOELECTRIC COLOR ANALYZERS

PHOTOELECTRIC COLOR COMPARATOR

PHOTO-ELECTRIC TUBES
Westinghouse Elec. & Mfg. Co.

PHOTOMETERS
Gaertner Scientific Corp.
Bausch & Lomb Optical Co.
Leeds & Northrup Co.

PHYSICAL TESTING MACHINES
Amthor Testing Inst. Co.
Atlas Electric Devices Co.
Claud S. Gordon Co.
Southwark Fdry. & Mach. Co.
A. Suter

PITOT TUBE METER
Brown Instrument Co.
Foxboro Co.

PLANIMETERS
Automatic Flow Record
Brown Instrument Co.
Foxboro Company
Linear
Brown Instrument Co.
Southwark Fdry. & Mach. Co.
Radial
Bristol Company
Foxboro Co.
Square Root
Foxboro Co.

POLARISCOPES
Gaertner Scientific Corp.

POSITION RECORDERS
Bristol Company
Foxboro Co.

are numbered according to the depths in relation to the diameter. In testing, the bar is mounted on a special rack, hung in the plating bath and plated. Conditions should be the same as those used for regular plating. When the time is up, the scale is removed from the bath and examined to see which cavities are completely covered by the deposit. The highest number on the cavities which are completely covered is taken as the throwing power of the bath. Outlines applications.—M. S.

Electrolysis Tests Quickly and Accurately Made. A. V. Smith. U. G. I. Circle, December, 1930, pages 4-7.

Buried iron pipes and lead cable sheaths are the conductors dealt with in this article, which describes in particular a special truck equipped for the testing of underground metallic structures. Truck designed by Albert F. Ganz, Inc. Equipment and method of its use are described.—M. F. B.

On the Geiger-Müller Tube as a Quantitative Ion-Counter. By K. A. Van den Akker, California Institute of Technology. The Review of Scientific Instruments, November, 1930, pages 672-683.

It is the purpose of the paper to show that within certain limits the new Geiger-Müller ion-counter tube is a quantitative detector of individual ions if certain precautions are observed and if a suggested method of analysis of the count-voltage curves is followed. The theory of the new Geiger-Müller tube is briefly expounded; the form of tube which was used in the reported experiments is described (a feature is a loud speaker placed in series with the counting mechanism in order that the qualitative nature of the impulses from the amplifier could be heard); the procedure is outlined (an interesting point is that the definiteness of the threshold voltage provides a valid test for the suitability of each individual tube); and the results reported. This constitutes exactly one-half of the paper—the second half deals with an explanation of the curves obtained, presents the theory and an analysis of the count-voltage curves and closes with notes on accuracy, said to be satisfactory only where rate of counting is moderate, say 300 per minute.—M. F. B.

The Measurement of the Voltage Operating a Self-rectifying X-ray Tube. C. V. Kent. Review of Scientific Instruments, January, 1931, pages 44-46.

Difficulties of measurement, and various methods, are discussed. The method described which has given successful results is based on fact that it requires a considerably higher voltage to produce a spark between a point and plate when the point is negative than when it is positive. It was found that this difference is sufficient to make the "inverse" voltage completely inoperative in producing a spark when the plate of the spark gap is connected to the filament of the tube and the point to the target. The sparking distance is then a function of the useful voltage only and can be used to determine it with the accuracy of the ordinary spark gap.—M. F. B.

By-Pass Condenser Production Test Equipment. Frank W. Stellwagon. Electronics, February, 1931, pages 504-505.

Describing a complete and compact test apparatus capable of testing more than 500 by-pass condenser units per hour. 5 figures.—M. F. B.

Electrical Distance Measurements. (Abstract from Elektrotechnik und Maschinenbau, Vol. 46, No. 10, 1929). Prof. A. Imhof. The Instrument World, February, 1931, pages 237-238.

A discussion of the Trub Tauber induction system of remote indications and recording.—M. F. B.

Measurement of Ionization Current by Means of the Zeleny Electroscope. Roger Barton. The Review of Scientific Instruments, February, 1931, pages 118-124.

The introductory section includes a description of the Zeleny Electroscope, in which intensity of ionization is not measured by the collapse of the leaf as in ordinary electroscopes, but in which the leaf is automatically recharged to a definite potential by striking a charged plate, so that the experimenter, instead of measuring the rate of collapse of the leaf, merely observes the frequency with which the leaf strikes the plate, thereby dispensing with a measuring microscope and making possible shadow projection. The theory of the method is next explained; and then the procedure for measuring an ionization current is outlined and brief directions are given.—M. F. B.

Triometer. Elekt. Zeitschrift Vol. 52 No. 10 March 5, 1931, page 324.

A precision moving-coil instrument made by Rob. Abrahamsohn, Inc., for measurements of voltage, ampere and resistance.—Ha.

A. E. G. Synchronizator. R. Dietze. A. E. G.-Mitteilungen, Mar. 1931, pages 144-148.

After discussing the requirements of automatic synchronization, the construction, wiring, and action of the new A. E. G. instrument are described.—Ha.

Coordinate Transformer (Koordinaten transformator). Elekrot. Zschr. Vol. 52, No. 9, Feb. 26, 1931, page 276-277.

This name has been given by the Elektrozweckverband Mitteldeutschland to an apparatus for transforming load diagrams taken in a certain coordinate system into another one. The instrument is especially useful for totalling the indications of several individual instruments and is based on the principle of the pantograph as the ordinates of a curve are changed in a given ratio which can be adjusted. The apparatus can perform automatically and continually without interruption 1 to read the time value, 2 to multiply them by a constant, 3 to record as a curve the multiplied values either as individual curve or as addition to an already existing curve. For a full one day record about 1 minute is required.—Ha.

Instrument for Measuring Energy Consumption in Three-Wire Three-Phase Installations (Verbrauchsmessgerät für Dreileiter-Drehstromanlagen). F. Kelbe. AEG-Mitteilungen No. 12, Dec. 1930, pages 780-782.

The instrument consists of two separate wattmeters in a common case which add the two individual readings to give the total consumption. By subtraction the reactive (wattless) power is obtained, and from the quotient wattless component divided by watt component (difference divided by the sum) of the two readings the power factor can be determined. The apparent consumption is then watt component divided by power factor. At the same time, the instrument shows also the maximum momentary energy.—Ha.

Peak Tarif Meters (Sperrschalt-Tarifzähler). Elektr. Zschr. Vol. 52, No. 9, Feb. 26, 1931, page 284.

Some new modifications and constructions of the Aronwerke A. G. of a meter in combination with a clock.—Ha.

New Siemens & Halske Megohmmeter. (Ein neues Megohmmeter von Siemens & Halske). M. Martens. Siemens-Zeitschrift, Vol. 10, No. 12, Dec. 1930, pages 620-624.

The instrument contains a generator which can be built for 400, 500, 1000 and 2500 volts. The measuring instrument is a cross-coil instrument with three coils to secure a poor initial sensitivity. A detailed description and illustrations are given.—Ha. & G. N.

Instrument for Testing Radio Tubes. (Roehrenpruefgeraet). Siemens Zeitschrift, Vol. 10, December 1930, pages 648-649.

Brief description of a simple instrument for testing radio tubes.—G. N.

POTENTIAL DETECTORS
Leeds & Northrup Co.
Westinghouse Elec. & Mfg. Co.

POTENTIOMETERS—Indicating
Brown Instrument Co.
Claud S. Gordon Co.
Leeds & Northrup Co.
Rubicon Company

Recording & Controlling
Claud S. Gordon Co.
Leeds & Northrup Co.

POWER FACTOR METERS
Jewell Electrical Instrument Co.
Westinghouse Elec. & Mfg. Co.
Weston Electrical Inst. Corp.

POWER FACTOR REGULATORS
Westinghouse Elec. & Mfg. Co.

PRESSURE RECORDERS
Bristol Co.
Brown Instrument Co.
Foxboro Co.
Taylor Instrument Cos.

PROCESS TIMING AND SIGNALING INSTRUMENTS
Bristol Company

PROGRAM INSTRUMENTS
Automatic Temp. Control Co.
Leeds & Northrup Co.

PROJECTION LANTERNS
Bausch & Lomb Optical Co.
Spencer Lens Co.

PROTRACTOR
Optical
Bausch & Lomb Optical Co.

PSYCHROMETER
Recording
Bristol Company
Foxboro Co.
Leeds & Northrup Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Sling
Taylor Instrument Companies

PYROMETERS

Optical
Claud S. Gordon Co.
Leeds & Northrup Co.

Radiation

Indicating
Brown Instrument Co.
Claud S. Gordon Co.
Leeds & Northrup Co.
Taylor Instrument Companies

Recording
Brown Instrument Co.
Leeds & Northrup Co.
Taylor Instrument Companies

Thermo-electric

Immersion
Bristol Company
Brown Instrument Co.
Claud S. Gordon Co.
Illinois Testing Labs., Inc.
Leeds & Northrup Co.
Taylor Instrument Companies

Indicating
Bristol Company
Brown Instrument Co.
Claud S. Gordon Co.
Illinois Testing Labs., Inc.
Leeds & Northrup Co.
Taylor Instrument Companies
Westinghouse Elec. & Mfg. Co.

Recording and Controlling
Bristol Company
Brown Instrument Co.
Claud S. Gordon Co.
Leeds & Northrup Co.
Taylor Instrument Companies

Surface Contact
Bristol Company
Brown Instrument Co.
Claud S. Gordon Co.
Illinois Testing Labs., Inc.
Leeds & Northrup Co.
Taylor Instrument Companies

RADIO FREQUENCY OSCILLATORS
General Radio Company
Jewell Electrical Inst. Co.

RADIO SET ANALYZERS
General Radio Company
Jewell Electrical Instrument Co.
Weston Electrical Inst. Corp.

RADIO TUBE CHECKERS
General Radio Company
Jewell Electrical Instrument Co.
Weston Electrical Inst. Corp.

RADIO TEST PANEL
Jewell Electrical Instrument Co.
Rubicon Company
Weston Electrical Inst. Corp.

REFRACTOMETERS
Bausch & Lomb Optical Co.
Spencer Lens Co.

REGULATORS—See Controls

RELAYS
General Radio Co.
Claud S. Gordon Co.
Jewell Electrical Instrument Co.
Minneapolis-Honeywell Co.
Westinghouse Elec. & Mfg. Co.
Weston Electrical Inst. Corp.

REMOTE METERING EQUIPMENT
Bristol Company
Brown Instrument Co.
General Electric Co.
Leeds & Northrup Co.
Westinghouse Elec. & Mfg. Co.

RESISTANCE—Electrical
General Radio Co.
Leeds & Northrup Co.
Rubicon Company
Spencer Lens Co.

RHEOSTATS
General Radio Co.
Rubicon Company
Spencer Lens Co.

ROTOSCOPE

RUBBER TESTING INSTRUMENTS

SACCHARIMETERS
Bausch & Lomb Optical Co.
Spencer Lens Co.
Taylor Instrument Companies.

SACCHAROMETERS
Tagliabue Mfg. Co., C. J.

SALINITY INDICATORS
Leeds & Northrup Co.
Rubicon Company

SCALES
Amthor Testing Instrument Co.
Gaertner Scientific Corp.
Alfred Suter

SCRATCH HARDNESS TESTER

SEISMOGRAPHS
R. Y. Ferner Co.

SERVICE RECORDERS

SHUNT METERS
Bristol Co.

SHUNTS
Jewell Electrical Instrument Co.
Leeds & Northrup Co.
Rubicon Company
Weston Electrical Inst. Corp.

SIGNALING DEVICES—Automatic
Brown Instrument Co.
Leeds & Northrup Co.
Rubicon Company

SLIDE RULES

SLOW SPEED MOTORS
Bodine Electric Co.

SMOKE INDICATORS & RECORDERS
Leeds & Northrup Co.
Westinghouse Elec. & Mfg. Co.

SOIL PRESSURE CELLS

SPECIAL INSTRUMENTS
Amthor Testing Inst. Co.
Burgess-Parr Co.
Meriam Co.

SPECIAL ELECTRICAL INSTRUMENTS
Atlas Electric Devices Co.
Bristol Co.
Brown Instrument Co.
General Radio Co.
Illinois Testing Labs., Inc.
Jewell Electrical Instrument Co.
Leeds & Northrup Co.
Rawson Electrical Instrument Co.
Rubicon Company
Weston Electrical Inst. Corp.

SPECIAL RECORDING DEVICES

SPECIFIC GRAVITY APPARATUS—Gas

SPECTROGRAPHS
R. Y. Ferner Co.
Gaertner Scientific Corp.

SPECTROSCOPES
Bausch & Lomb Optical Co.
R. Y. Ferner Co.
Gaertner Scientific Corp.
Spencer Lens Co.

SPECTROPHOTOMETERS
Bausch & Lomb Optical Co.
Gaertner Scientific Corp.

SPEED INDICATORS
See Tachometers

SPEED RECORDERS
Amthor Testing Inst. Co.
Brown Instrument Co.
Leeds & Northrup Co.

STANDARD CELLS
Weston Electrical Inst. Corp.

STEEL TAPES

STOP WATCHES
R. Y. Ferner Co.

STRAIN GAGE
Southwark Fdry. & Mach. Co.
Alfred Suter

STRESS INDICATOR

STROBOSCOPES

SULPHUR DIOXIDE METERS
Leeds & Northrup Co.
Tagliabue Mfg. Co., C. J.

SULPHUR DETERMINATION APPARATUS
Burgess-Parr Co.
Tagliabue Mfg. Co., C. J.

SUNSHINE RECORDERS
Leeds & Northrup Co.
Taylor Instrument Companies

SURGE RECORDERS

SYNCHRONIZING FORKS—Electrical
General Radio Co.
Leeds & Northrup Co.

Thermal Wattmeter of Modern Design (Ein thermischer Leitungsmesser neuzeitlicher Konstruktion). H. V. L. Bruckman and W. J. Reichert. Elektrotechnik und Maschinenbau, Aug. 24, 1930, pages 781-785.

Describes an instrument which is very serviceable in many cases where the electrodynamic wattmeter fails because of the errors inherent in its system. Gives critical analysis of the thermal wattmeter, and indicates by means of examples what can be expected of it, and what corrections are necessary in particular cases. Treats of several possible practical applications.—M. S.

Bridge Connections for the Approximate Measurement of the Ratio of Transformation of Transformers (Eine Brückenschaltung zur angenäherten Messung des Uebersetzungverhältnisses von Transformatoren). E. Mittelmann. Elektrotechnik und Maschinenbau, July 20, 1930, pages 697-698.

Shows that it is possible to use the standard Wheatstone bridge with AC supply and telephone. —M. S.

Fluxmeter. Electrical Review, Nov. 17, 1930, page 844.

Description of the "Grassot" fluxmeter produced by the Cambridge Instrument Co., Ltd., London. It is a suspended-coil galvanometer specially designed for the investigation of magnetic fields.—M. S.

Power-Factor Indicators. S. B. Warden. Electrical Review, Dec. 19, 1930, pages 1036-1037.

Considerable saving can be effected by locating the power-factor on the low-voltage side of a rotary-converter. Shows that with the converter arranged for booster control, the difference between power-factors on the primary and secondary sides of the transformer is so small that it is immaterial which side the indicator is connected. In the case of reactance-controlled machines the power-factor is tied up by the load and d.c. voltage and cannot be adjusted. Therefore, it makes no serious difference where the indicator is connected.—M. S.

New Fault Localizer. Electrical Review, Nov. 14, 1930, pages 843-844.

Description of "Hurdy Gurdy" instrument introduced by Messrs. Price and Belsham, Ltd., London. Based on the "double-bridge" principle. A portable galvanometer and a high-pressure battery or a hand generator are required in addition when making a test. Involved calculations are eliminated.—M. S.

Phase Indicator Has 50- to 500-Volt Range. Electrical World, Vol. 97, Jan. 17, 1931, page 168.

The Knopp phase sequence indicator, manufactured by the Meter Devices Co., Canton, Ohio, determines quickly and accurately the correct phase rotation, is used in checking connections of watt-hour meters and reactive component meters for determining the correct phase rotation, and develops a very high torque, 750 mmg. at 220 volts. Its voltage range is 50-500 volts.—W. H. B.

Testing Set Measures Dielectric Strength. Electrical World, Vol. 97, Jan. 24, 1931, page 212.

An apparatus ideally suited for light testing in factory or laboratory where potentials from 500-20000 volts at 1 kva. is the Amer Tran type TS-15A marketed by the American Transformer Co., Newark, N. J. This testing set operates from standard 110-volt, 60 cycle circuits and contains a special air-cooled testing transformer with a 4-section secondary winding which permits of obtaining three different voltages at full output—5000, 10000, and 20000. The equipment also includes a wire-sound potentiometer for adjusting the voltage to any value between zero and maximum. The exact value is indicated by a precision double-range voltmeter connected to a special winding on the transformer.—W. H. B.

MAGNETIC INSTRUMENTS

A New Flux-Voltmeter (Ein neues Flux-Voltmeter) G. Stein. El Zschr. vol. 52, No. 4, Jan. 22, 1931, pages 117-118.

This instrument is a modification of that of Camilli and registers by means of an oscilograph the curves of the magnetic flux in an iron curve as function of the time. Proportionality between flux and current is obtained by a special reactance coil which is connected in parallel to the transformer and is designed for constant self-induction from 50 to 500 volts.—Ha.

Instrument for Measuring Small Alternating Magnetic Fields (Gerät zur Messung Kloiner magnetischer Wechselfelder). G. Lubszinsky. Elekt. Zeitschrift, Vol. 52, No. 10, March 5, 1931, pages 312-314.

The cathode oscillograph is very sensitive against even very small magnetic alternating fields, and the instrument described was devised to investigate and determine such small fields which might be of the order of 10^{-4} gauss. Due to the nature of the fields it must be possible to measure fields with a frequency from $16\frac{2}{3}$ to 300,000 periods per second. The measurement is accomplished by a small test coil the voltage at the end of which is rectified in a first tube and then amplified until the current can be read on a milliammeter. Construction, calibration, sensitivity and some tests are described. The instrument is not only for laboratory use but is portable for measuring magnetic conditions around machines, transformers, transmission lines, etc. under operating conditions. The instrument was developed in the high-tension laboratory of the Technische Hochschule, Berlin.—Ha.

Measuring Reactance Coil for Highest Tensions (Messdrosselspule for Höchstspannungen). J. Goldstein. Forschung und Technik 1930, pages 313-318.

The apparatus described is used for 220 KV and is essentially a reactance coil with two iron cores symmetrically arranged at the ends as part of the magnetic flux; on the lower iron core (the coil is mounted vertically) the low-tension measuring coil is placed. The adjustment for proportionality in indicating voltage is made by connecting an ohmic resistance in parallel to the lower part of the high-tension winding which sits over the low-tension coil. Theory and error-curve are discussed. The errors up to 100 VA load remained within 1.3% for as poor a power factor as 0.5.—Ha.

Electromagnetic Method for Testing Large Rotors for Hidden Defects of Manufacture (Elektromagnetisches Verfahren zur Prüfung grosser Induktorkörper auf verborgene Herstellungsfehler). R. Pohl. Forschung und Technik, 1930, pages 455-468.

A method is described by which hidden defects in large cylinder forged pieces with an axial bore can be detected. A current of from 1000 to 2000 amperes is sent from one side of the piece, such as a big shaft, to the other side diametrically across from it so that it flows to both sides of the bore. If a coil is placed in the latter and the current broken or reversed, the coil which is connected to a very sensitive mirror galvanometer will be subject to a magnetic field should magnetic asymmetry be present due to defects. The method is theoretically discussed and instruments described, as well as test results on a shaft of 5280 mm. length, 495 mm. diameter and 69.5 mm. bore. The sensitivity of the method is very great and is little influenced by exterior disturbances. Some suggestions are added to make this method still more convenient for practical application.—Ha.

Magnetic Steel Analysis According to Malmberg (Magnetische Stahlanalyse nach Malmberg). Elektrotechnische Zeitschrift, Vol. 52, Jan. 15, 1931, page 80.

For the quick determination of the C content of Fe, Malmberg uses the permeability which changes with the C content changes. The sample is exposed to a magnetic field, changing repeated-

SYNCHRONOUS MOTORS
Bodine Electric Co.

TACHOSCOPES
Amthor Testing Inst. Co.
Brown Instrument Co.

TACHOMETERS
Amthor Testing Instrument Co.
Bristol Company
Brown Instrument Co.
Foxboro Co.
Westinghouse Elec. & Mfg. Co.
Weston Electrical Inst. Corp.

TELESCOPES
Bausch & Lomb Optical Co.
R. Y. Ferner Co.
Gaertner Scientific Corp.

TENSILE TESTERS FOR PAPER WIRE, SHEETS, ETC.
Amthor Testing Instrument Co.
Alfred Suter

TENSOMETER (Huggenberger)
Southwark Fdry. & Mach. Co.

TESTERS, Gas

TESTING MACHINE

Portable—Tensile—Compression
Southwark Fdry. & Mach. Co.

Universal
Amthor Testing Inst. Co.
Claud S. Gordon Co.
Southwark Fdry. & Mach. Co.
A. Suter

TEXTILE TESTING INSTRUMENTS
Atlas Electric Devices Co.
A. Suter

THEODOLITES

THERMO-JUNCTIONS (Electric)
General Radio Co.
Rawson Electrical Instrument Co.

THERMOMETERS

Gas Filled
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Mechanical
Brown Instrument Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.

Mercurial
Bristol Co.
Claud S. Gordon Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Resistance
Brown Instrument Co.
Claud S. Gordon Co.
Illinois Testing Labs., Inc.
Leeds & Northrup Co.

Vapor-Tension
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Wet & Dry Bulb
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Leeds & Northrup Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

THERMOSTATS
Bristol Company
Brown Instrument Co.
Foxboro Co.
Claud S. Gordon Co.
Minneapolis-Honeywell Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

TIME OPERATION RECORDERS
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ly between 2 fixed values. The difference in magnetic induction measured by a ballistic galvanometer indicates the C content. This method seems to be particularly useful for melts and has, therefore, been recommended by the chamical Committee of the Verein deutcher Eisenhüttenleute. Directions for the application of this method and the necessary instruments are given.—Ha.

Magnetic Testing of Steels (Die magnetische Prüfung von Stählen). Kuehmel & Pusch. Zeitschrift Verein deutscher Ingenieure, Vol. 74, Nov. 12, 1930, page 1521.

More recent methods use, instead of direct current, alternating current and an oscillograph for both indicating and recording. In this way, defects, heat treatment, hardness, inclusions, segregations, etc. can be determined as well as the quality of welded seams. The instrument is built by the Magnetic Analysis Corp., Long Island City, N. Y. A few records are given.—Ha.

A Method for the Standardization of Permeameters at High Magnetizing Forces. Raymond L. Sanford. Bureau of Standards Journal of Research, March 1931, pages 355-362.

A description of apparatus suitable for the testing of standard magnetic test bars to be used for the standardization of magnetic permeameters with high magnetizing forces. A criterion is given for determining when accurate values have been obtained. Attention is called to the necessity that the standards shall be magnetically uniform.

Magnetic Testing of Non-uniform Material (Prüfung ungleichmässigen Wenkstoffs auf magnetischen Wege). W. S. Messkin, Archiv for Eisenhüttenwesen, Vol. 4, Oct. 1930, pages 215-220; Stahl und Eisen, Vol. 50, Dec. 11, 1930, page 1751.

The author describes a new method to determine the magnetic properties of non-uniform material, i.e., material, the core of which has other magnetic characteristics than the skin. Exact determinations of the normal induction curve show that it is really composed of 2 branches provided the material is non-uniform. From these curves, the maximum permeability can be found by a simple geometric procedure and the coercive forces can then be determined by certain approximative calculations. These approximative formulae are given as well as the theoretical principles of this new method.—G. N.

Magnetic Switches in Regulatory Circuits. Charles G. Maier, (Pacific Experimental Station, U. S. Bureau of Mines, Berkeley, Cal.) Industrial & Engineering Chemistry, Analytical Edition July 15, 1930, page 258.

Attention is drawn to the use of telegraph relay and an alternating current magnetic switch for use in regulating circuits as being cheaper than other types and very serviceable.—M. E. H.

A Magnetization-Curve Tracer. By F. E. Haworth. Bell Laboratories Record, December, 1930, pages 167-170.

A new apparatus has been developed which draws a continuous curve of magnetic flux density in the sample against the exciting field strength. Heretofore, with the ballistic galvanometer, the exciting current has been changed in small steps and the induced current momentarily swings the galvanometer to a deflection proportional to the change in flux. Such a method is necessarily slow. The new method has the advantage of rapidity, but its principal advantage is that it produces a continuous curve rather than a series of disconnected points. Instead of a ballistic galvanometer a fluxmeter is employed. To prevent even the slow return caused by the small restoring torque of the fluxmeter, an ingenious arrangement of a photoelectric cell with wedge-shaped opening is used, on the point of which the light reflected by the fluxmeter mirror falls when the fluxmeter is undeflected. As a result of this arrangement the deflection of the fluxmeter is always proportional to the flux in the specimen. The graph is made on a sheet of sensitized paper fastened to a drum, the rotation of which carries the exciting field of the specimen (light from a second lamp falls on the fluxmeter mirror at an angle of incidence different from that of the lamp actuating the photoelectric cell). The paper gives illustrations of several curves, including one showing irregulatrities in a hysterisis loop, which the usual method would probably not have revealed.—M. F. B.

A Ballistic Hysteresigraph. Henry C. Lehde. Review of Scientific Instruments, January, 1931, pages 16-43.

Apparatus is based on principles of ballistic method. Ammeter and ballistic galvanometer or fluxmeter are combined to record automatically the values of magnetizing force and magnetic flux. This is done by making a beam of light trace out the desired curve on a photographic plate. Mirrors attached to the moving coils are arranged to deflect the beam of light simultaneously. Instrument combines convenience of cathode ray hysteresigraph with an accuracy probably greater than that of conventional method. In the modified forms of ammeter and fluxmeter used, several sources of error inherent in these instruments are eliminated or materially reduced. Discussions and numerous illustrations are given of applications of the new instrument to: Hysteresis loops, magnetization curves, etc. Theory of the fluxmeter is mathematically discussed. Possible sources of error are outlined. Comparison with ballistic method, calibration of instrument, design of fluxmeter and characteristics of the instrument, are discussed.—M. F. B.

VIBRATION & ACOUSTICS

The Measurement of Sound Absorption. V. L. Chrisler and W. F. Snyder. Bureau of Standards, Journal of Research, October 1930, pages 957-972.

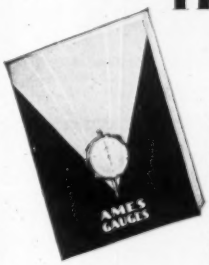
This paper contains a brief discussion of the theory of reverberation measurements. The reverberation room is described and details are given as to the method of measuring sound absorption by means of the ear. Methods are also described by which sound absorption can be determined from oscillograph records or by the use of an attenuator box and vacuum tube voltmeter.

Balancing Dynamically of Rotating Parts (Die Auswuchtung rotierender Apparateteile). W. Spaeth. Elektrotechnische Zeitschrift, Jan. 16, 1930, pages 86-89.

Describes an electrical equipment for the determination of location and magnitude of dynamic unbalance in rotating parts which is suitable particularly where measurements of quantity production of small parts is wanted. It consists mainly in producing artificially vibrations which counteract those vibrations produced in the testing apparatus by the unbalance of the body to be balanced dynamically. A few types of such apparatus are described and their sensitivity and accuracy are discussed.—Ha.

Measurement of Loudness of Noises (Die Messung von Geraeschstaerken). Wawrziniok. Messtechnik, Sept. 1930, pages 241-242; Automobiltechnische Zeitschrift, (1929) page 780, 832-834.

An improved method for the measurement of irregular sounds and noise is described which eliminates greatly the disadvantages of subjective methods used so far. The sound to be measured is received in a microphone and the current of the latter transmitted to the measuring room where it is sent through an electron tube relay in which it is amplified by a definite amount. This sound is then made audible in a loud speaker. In place of the original microphone a sound producer is connected every second so that the 2 sounds can be compared. By a regulating resistance the comparison sound can be varied in strength; the change in resistance necessary to equalize both sounds gives an objective measure for the loudness. The whole arrangement is described in detail. —Ha.



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RICHARD RIMBACH, INSTRUMENTS, Vol. 4, No. 7, July 1931, pages 369-373, 10 figs.

The various exhibits are described.

Professor Samuel Wilson Parr

JACKSON BURGESS, INSTRUMENTS, Vol. 4, No. 7, July 1931, pages 374-376, 1 fig.

A biography.

Speed and Acceleration

M. F. BEHAR, INSTRUMENTS, Vol. 4, No. 7, July 1931, pages 377-394, 9 figs.

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